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INSTRUCTION MANUAL

MODEL 305

TRACKING
WAVE and SPECTRUM ANALYZER

FOR SERIAL NO. 154

Quan-Tech
DIVISION OF KMS INDUSTRIES, INC.

INSTRUMENTS • AMPLIFIERS • NOISE INSTRUMENTATION

INSTRUCTION MANUAL

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WAVE and SPECTRUM ANALYZER

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Q U A N - T E C H
DIVISION OF KMS INDUSTRIES, INC.

43 SO. JEFFERSON ROAD WHIPPANY, NEW JERSEY 07981

201-887-5508

CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be tested as soon as it is received. If it fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to us. We will then advise you of the disposition to be made of the equipment and arrange for repair or replacement. Include model number and serial number when referring to this instrument for any reason.

WARRANTY

Quan-Tech Laboratories, Inc. warrants each instrument manufactured by them to be free from defects in material and workmanship. Our liability under this warranty is limited to servicing or adjusting any instrument returned to the factory for that purpose and to replace any defective parts thereof. Electronic tubes and batteries are specifically excluded from any liability. This warranty is effective for one year after delivery to the original purchaser when the instrument is returned, transportation charges prepaid by the original purchaser, and when upon our examination it is disclosed to our satisfaction to be defective. If the fault has been caused by misadjustments, misuse, or abnormal conditions of operation, repairs will be billed at cost. In this case, an estimate will be submitted before the work is started.

Calibration checks of this instrument can easily be made in accordance with the instruction manual. Routine readjustments should never be attempted. If, however, the instrument has been damaged and requires recalibration or alignment, explicit calibration procedures as defined in the instruction manual must be followed.

If any fault develops, the following steps should be taken:

1. Notify us, giving full details of the difficulty, and include the model number and serial number. On receipt of this information, we will give you service data or shipping instructions.

2. On receipt of shipping instructions, forward the instrument prepaid, to the factory. If requested, an estimate of the charges will be made before the work begins provided the instrument is not covered by the warranty.

SHIPPING

The instruments should be packed in their original containers, or in a strong exterior container and surrounded by two inches of shock absorbing material.

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A. DESCRIPTION

The Model 305 is an extremely versatile multi-purpose instrument. It is not only useful as a precision wave analyzer for harmonic measurements and Fourier analysis of complex signals, but its three selectable flat-top bandwidths make it ideally suited for spectral density analysis of random signals.

The Model 305 features electronic tuning, using an extremely stable and precise voltage controlled oscillator. A 5000 division linear scale is provided for manual tuning. A six position MODE switch controls the tuning functions of the Model 305. In the OFF position the instrument acts as a normal, manually tuned wave analyzer. In the AFC position the analyzer will lock onto a drifting signal and follow it over a limited frequency range determined by the bandwidth. In the TRACK position, the instrument will lock onto a signal and follow it over the whole or discrete portions of the tuning range. In the SWEEP position the analyzer will start at the frequency to which the tuning dial is set, and scan upward in frequency over the whole or discrete portions of the tuning range, as determined by a sweep increment switch. In the SEARCH & TRACK position, the instrument will scan as in the SWEEP position until it finds a signal, whereupon it will lock onto the signal and track it as in the TRACK position. If the signal disappears, the analyzer will continue to scan automatically until the original signal or a new one appears. Since the sweep time, sweep increment, averaging time, and bandwidth are interdependent, a red light will appear if the various switches are set to a combination which would lead to erroneous results. With the MODE switch in the EXT position, the instrument may be tuned by an external DC voltage.

Two or more Model 305's may be connected together without modification to form a multi-channel, phase locked, master-slave analyzer system suitable for mechanical impedance and transfer function analysis. *

A multiplicity of outputs greatly increases the versatility of the Model 305. When used with an X-Y plotter, it can automatically make an amplitude vs. frequency or amplitude-phase plot of the characteristics of an electronic or electromechanical system. The Model 305 when

used with an oscilloscope, X-Y plotter, or strip-chart recorder becomes a spectrum analyzer whose center frequency, sweep width and resolution can all be varied over wide limits. Averaging time, bandwidth, and sweep speed can be selected for optimum results in random signal analysis.

*Accessory Model 1305 Slave Filter and Phasemeter. In multi-channel installations where the slaved units never need to work independently, we recommend the Model 1305 which has a built-in phase meter but no tuning or sweep features. Mechanical impedance and transfer function analysis is simplified and at a considerable saving in cost.

B. SPECIFICATIONS

FREQUENCY
RANGE: 10 Hz to 50 KHz
ACCURACY: ± 0.5% or 10 Hz
DIAL: Linear, 10 Hz per division

SELECTIVITY
Three pass bands, 10 Hz, 100 Hz, and 1000 Hz at 3 db down, selectable by front panel switch. Maximally flat (Butterworth approximation) with 24db roll-off. Also broadband 10 Hz to 65 KHz.

SENSITIVITY
RANGE: 30 μV to 300 volts full scale in 10db steps. Also variable gain control of 20db.
DYNAMIC RANGE: > 70db for Fourier analysis, > 40db for random signal analysis.
ACCURACY: ±5%

INPUT IMPEDANCE
1 Megohm

AVERAGING TIMES
Approximately < 0.1, 1, and 10 seconds, switch selectable.

TUNING MODES
Manual, Manual plus AFC, Track, Sweep, Search and Track, external.

AFC
Will hold over approximately 4 bandwidths

TRACK
INCREMENT: ±0.5, 1, 5, 10, or 50 KHz from dial setting, switch selectable.
THRESHOLD: Adjustable from approx. 2% to 50% of full scale.

SWEEP
TIME: 0.5, 5, 50, or 500 seconds, switch selectable.
INCREMENT: 0.5, 1, 5, 10, or 50 KHz, switch selectable.
MODES: Single or repetitive, with reset.

OUTPUTS ON FRONT PANEL
SWEEP ANALOG: 0 to +5 volts for any sweep increment.
AMPLITUDE ANALOG: 0 to 10 volts proportional to meter deflection.
BFO: Sine wave output at the frequency to which the instrument is tuned. Variable to at least 1 volt RMS into 600 ohms.
RESTORED FREQUENCY: A replica of the input signal filtered in accordance with tuning and bandwidth. Variable to at least 0.5 volt RMS into 600 ohms for full scale.

Note: Either BFO or Restored output is selected by a switch. Simultaneous BFO and Restored available as an option.

AVAILABLE AT REAR CONNECTOR:
Same outputs as on front panel, plus:
FREQUENCY ANALOG: DC output proportional to the frequency to which the instrument is tuned ± 0.1mv/Hz, +5V max.
EXTERNAL SWEEP INPUT: ± 5V max. for ± sweep increment from dial setting.
PHASE OUTPUTS: In-phase and quadrature components, each equal to at least 5 volts peak-to-peak for full scale deflection.
MASTER-SLAVE CONNECTIONS: 100 KHz crystal controlled, 100 to 150 KHz variable.
CARRIER OUTPUT

EXTERNAL BATTERY CONNECTIONS: Plus, minus, and ground.

POWER INPUT
117/234 VAC, 50 to 400 Hz, 18 Watts or plus and minus 28VDC at 300 ma.

DIMENSIONS:
11 1/16"X15"X11 1/4". Weight 26 lbs.

A thorough understanding of an instrument and its principle of operation greatly enhances its usefulness. The Model 305 Wave and Spectrum Analyzer is a precision instrument capable of performing accurate signal analysis. For the most effective application of this equipment we strongly recommend that the prospective operator read Section 3, the Theory of Operation, before using the instrument.

A study of both the block diagram and the following description, along with the panel markings, will help to familiarize the operator with the functions of the various panel controls.

A. DESCRIPTION OF CONTROLS, INPUTS AND OUTPUTS

1. MANUAL TUNING - The COARSE, FINE and ZERO controls each, by means of electro-mechanical linkage, can change the frequency of a voltage controlled oscillator (VCO) thereby tuning the instrument. The controls differ in both range and resolution, but are alike in that each control precisely converts angular motion to a change in frequency of the VCO.

   Listed below is the range and resolution of each:

   COARSE - 50 KHz max., 3500 Hz/rev.
   FINE - 50 KHz max., 1000 Hz/rev.
   ZERO - 2000 Hz max., 200 Hz/rev.

2. AUTOMATIC TUNING MODES - In addition to manual control of the VCO, provision has been made to electronically tune it in any of several modes as selected by the MODE switch.

   a. In the AFC mode, the instrument will tend toward a phase lock condition with a signal component which moves no more than four instrument bandwidths.

   b. In the TRACK mode, the instrument will track a moving signal over selectable increments of the instrument tuning range. Increment width is selected by means of the RANGE control. A rear access control (TRACKING THRESHOLD ADJUST) is provided to permit amplitude discrimination of the tracked signal.

c. In the SWEEP mode, the operator may scan in its entirety or incrementally, the spectrum from 10 Hz to 50 KHz. The increment width again is selectable by means of the RANGE control. The scan time per range increment is selectable by means of the TIME control (.5 to 500 seconds).

d. The SEARCH AND TRACK mode is a combination of the Sweep mode and the Track mode. One may electronically scan the spectrum or portions thereof as in the Sweep mode. When a signal of given amplitude, as determined by the TRACKING THRESHOLD ADJUST is found, the instrument will automatically switch to the Track mode and track the signal. If the signal moves beyond the range increment or drops below the pre-set threshold, the instrument will revert to the scanning mode until it once again finds a signal.

e. Provision has been made for the operator to externally program the electronically tuned VCO by means of a connector on the rear apron of the instrument. This function is accomplished with the MODE switch in the EXT position.

The RESET/SINGLE/AUTO switch provides for single or repetitive scanning in the SWEEP or SEARCH and TRACK modes of operation

The RESET is a defeat position for the AFC and TRACK modes as well as for the SWEEP or SWITCH AND TRACK modes. The mode analog voltage is available at the SWEEP ANALOG jack for operating oscilloscopes, recorders, etc.

3. MASTER-SLAVE Mode

This mode of operation is controlled by a switch at the rear of the Model 305. For normal or master operation, the MASTER-SLAVE switches are left in the MASTER position. The switches are thrown to the SLAVE position if one wishes to drive one or more 305's as phase locked slave units subordinate to a 305 designated as MASTER. For instance, if one wishes to make simultaneous electronic measurements upon two or more points related in phase and amplitude

by some complex transfer function, one may use two or more 305 Wave Analyzers as slaved units, phase locked to and driven by the master unit.

4. SENSITIVITY - The METER MULTIPLIER, VARIABLE GAIN and MILLIVOLTS FULL SCALE controls set the instrument's sensitivity and provide for a combined range of 130 db. The METER MULTIPLIER and VARIABLE GAIN controls are associated with the input circuits and serve to adjust the input signal level to the correct value for analysis. The MILLIVOLTS FULL SCALE switch is in essence a range switch for the voltmeter. The sensitivity of the analyzer is increased in 10 db increments as this control is rotated counter-clockwise. For absolute amplitude measurements, the 20 db VARIABLE GAIN control should be rotated clockwise to the CALIBRATED detent. The meter will then read directly in millivolts x the METER MULTIPLIER.

5. SELECTIVITY - The overall pass band of the system is controlled by the BANDWIDTH switch and may be set to 10, 100 or 1000 Hz or 65 KHz. Refer to the curves in Figure 2 for typical filter response characteristics. In the 65 KHz position, the instrument functions as a broadband AC averaging voltmeter. This position is used to determine whether or not a signal exists in the input which might tend to overload the instrument. The instrument full scale reading in this case is equal to the METER MULTIPLIER setting x 1000 mv.

6. METERING - The METER T.C. switch provides for the selection of meter averaging times. The operator will find it helpful in that the averaging time can be changed by the same ratio as the system bandwidth namely, 10:1. The selectable averaging time is of particular usefulness in the measurement of noisy signals.

The METER ZERO controls provide a means of periodically balancing critically matched circuits which are subject to change with time and temperature. Circuit unbalance is indicated by a finite meter reading with no signal applied and should be "zeroed out" for correct operation.

For recording purposes, the METER ANALOG voltage is made available both at a jack on the front panel and at a control at the rear of the instrument.

7. BFO AND RESTORED - Either of these signals may be selected and its amplitude adjusted by the two controls provided. The BFO is a sine wave equal to the frequency to which the instrument is tuned, whereas the RESTORED signal is equal to the input signal after it has been passed through a 10, 100 or 1000 Hz filter and therefore is only available when the instrument is tuned to an input signal.

B. INITIAL OPERATION

1. Connect the instrument to a suitable source of power.

   a. AC Operation. Refer to plate located near the power cord for the voltage and frequency for which the instrument is wired. (See Section 4)

   b. DC Operation. Connect 2 batteries, each 20-32VDC @ 200 MA per hour to connector at rear of instrument. See Figure 3 for pin connections.

      CAUTION: AC power cord MUST NOT be connected to a source of power.

2. Allow at least 10 minutes for the instrument to stabilize before making any adjustments.

3. Calibrate the dial for frequency accuracy as follows:

   a. Set panel controls as indicated below:

(1)	MILLIVOLTS FULL SCALE	30
(2)	METER TC	<.1
(3)	VARIABLE GAIN	CALIBRATED
(4)	METER MULTIPLIER	XI
(5)	BANDWIDTH	1000
(6)	FREQUENCY DIAL	000
(7)	SWEEP	OFF
(8)	PHASE/NORMAL switch	NORMAL

b. Tune the FREQUENCY ZERO control for a maximum meter reading (20-30 MV).

c. Set BANDWIDTH to 100 cycles and again peak meter reading.

d. Switch to a bandwidth of 10 cycles and very slowly adjust the FREQUENCY ZERO for a maximum meter reading. A low frequency beat will occur if the meter zero has not been adjusted.

4. Zero the meter as follows:

a. Set the dial such that the instrument is tuned neither to an incoming signal nor the 000 carrier.

b. Turn the MILLIVOLTS switch counterclockwise to progressively more sensitive ranges. As the sensitivity of the instrument is increased, a residual voltage may be discernible. Alternately adjust the METER ZERO controls for a minimum meter reading, adjusting for the best possible null on the most sensitive range.(This should be less than 1% of full scale.)

NOTE: The instrument is now ready for operation. However, for best performance the above procedure should be repeated periodically.

C. MANUAL OPERATION

Since the exact procedure for operating the controls depends in large part on the nature of the test to be performed, consider the following example of manual operation.

A one volt, 10 KHz signal is to be analyzed for harmonic distortion.

1. Set BANDWIDTH switch to 65 KHz

2. Set MILLIVOLT FULL SCALE switch to 1000

3. Set METER MULTIPLIER switch to x 1 .

4. Turn the VARIABLE GAIN control clockwise to detented CALIBRATED position.

5. Select a METER T.C. of <.1 sec.

6. Connect the signal to the INPUT
(The black post is chassis grounded.)

The meter should read approximately full scale. If it does not, the VARIABLE GAIN control may be adjusted such that it does. If the meter reads over full scale, it indicates that there is a signal present at the INPUT, lying within the range 10 - 65 KHz which will overload the instrument front end. If the range of the VARIABLE GAIN control is not sufficient to bring the meter reading to full scale, the METER MULTIPLIER should be switched to the x 10 or x 100 position in order to do so.

7. Set the BANDWIDTH to 1 KHz

8. Tune the FREQUENCY dial to the 10 KHz signal

9. Adjust MILLIVOLTS FULL SCALE switch to obtain a full scale meter reading.

If there had been only the 1 volt 10 KHz signal present at the INPUT the meter would have read full scale in the 65 KHz BANDWIDTH switch position with a METER MULTIPLIER setting of x 1 and a MILLIVOLTS FULL SCALE setting of 1000. The presence of a signal of greater than 1 volt amplitude at some frequency other than 10 KHz necessitates decreasing the input sensitivity to prevent overloading, hence one must increase in proportion the metering circuit sensitivity when examining the 10 KHz signal with the BANDWIDTH switch in one of the more selective settings.

Now that both the amplitude and frequency of the fundamental signal are known, measure the second harmonic content by setting the dial to twice the fundamental frequency (approx. 20 KHz). Rotate the MILLIVOLTS FULL SCALE switch counter-clockwise until the meter reads up scale. This measure of the second harmonic may now be related to the fundamental signal by expressing its magnitude in percentage of, or decibels below one volt. Similarly by successively tuning to 30, 40 and 50 KHz the magnitude of the third, fourth and fifth harmonics of the fundamental may be measured.

D. AUTOMATIC MODES

1. AFC

a. Adjust instrument as in steps 1 - 9 of Manual operation.

b. Set the SINGLE/AUTO/RESET switch to RESET position (effective AFC defeat).

c. Set MODE switch to AFC position.

d. When SINGLE/AUTO/RESET switch is switched to either SINGLE or AUTO, the AFC becomes effective.

The AFC will hold for approximately 4 times the BANDWIDTH switch setting. The AFC mode time constants are therefore dependent upon the bandwidth selection and are as follows:

BANDWIDTH (Hz)	10	100	1000
TIME CONSTANT (Sec.)	2.5	.25	.025

2. TRACK

a. With MODE switch in OFF position tune instrument to a desired signal component as in Sect. C (MANUAL OPERATION).

b. Set RESET/SINGLE/AUTO switch to RESET position.

c. By means of the RANGE switch, select the spectrum increment over which it is desired to track the signal.

d. Choose the bandwidth and meter time constant as required (see note).

e. Set the TIME switch to the shortest time which does not light the red indicator lamp. (see note)

f. Switch the RESET/SINGLE/AUTO switch to AUTO. The instrument will now track the signal over the range $\pm (\Delta f)$ from the manually set dial frequency (f).

g. Determine over what range of amplitude variation the 305 is to remain locked onto the signal.

h. With signal initially at full scale meter deflection, attenuate the signal input by means of the METER MULTIPLIER and/or VARIABLE GAIN controls until the meter deflection indicates the amplitude point at which it is desired that the instrument cease tracking the signal.

i. De-tune the manual tuning by several bandwidths and adjust the TRACKING THRESHOLD adjustment at rear of instrument until the meter indication suddenly drops to 0; implying that the instrument has indeed ceased to track the signal.

3. SWEEP

a. Set FREQUENCY dial to the frequency at which the sweep is to start.

b. Select the SWEEP width; .5, 1, 5, 10 or 50 KHz.

c. Set the SWEEP time (See Note).(.5,5,50,or 500 sec.)

d. Select the bandwidth and metering time constant as required. (See Note).

e. To initiate the sweep, operate the RESET/SINGLE/AUTO switch first to RESET then back to either the AUTO or SINGLE positions.

(1) AUTO - Instrument will continuously scan the selected frequency range.

(2) SINGLE - Instrument will make one scan, stopping at the top of the selected frequency range. The unit will then maintain this tuning until manually detuned or reset.

4. SEARCH AND TRACK

a. The instrument is adjusted as in the Sweep mode of operation with the exception that when it finds a signal it will switch to the Track mode of operation and hence the TRACKING THRESHOLD ADJUST must be set as in the paragraphs covering the Track mode operation.

Note that as in the Sweep mode, the instrument scans upward through a given range increment, whereas once a signal has been found, the instrument will track both + and - from dial setting by that same range increment.

5. EXT

In this mode of operation a ± 5V control voltage applied to the EXTERNAL input at the rear connector of the instrument will electronically tune the instrument by the RANGE increment (f), ± from the dial setting, FREQUENCY (f).

NOTE:

In the interest of providing maximum versatility, the bandwidth, sweep, and averaging time controls have not been interlocked such as to always provide maximum accuracy. The operator must therefore consider with care his choice of settings.

The field of waveform and spectrum analysis is both broad and complex. There are, however, several excellent texts and articles published on the subject and therefore no attempt will be made in this short manual to cover it thoroughly; instead listed below are a number of basic formulae and notes intended merely to serve as a guide to the effective usage of the equipment.

a. Sweep or Track rate(Hz) $= \frac{\text{Sweep or Track RANGE}(\Delta f)}{\text{Sweep or Track TIME per}(\Delta f)}$

$$\text{or } SR = \frac{W}{T}$$

b. The maximum SR, with regard to bandwidth, should not exceed the following formula:

$$SR_{(Max)} = \left(\frac{BW}{2}\right)^2$$

This refers to the analysis speed limitation imposed by the system bandwidth and can be violated only at the expense of accuracy.

c. The averaging time (METER T.C.) should be selected according to the accuracy requirements of the particular test. In the case of pure random noise, the statistical error (e) due to finite filter bandwidth and averaging time may be estimated by:

$$e = \sqrt{\frac{1}{2BW \times TC}}$$

where:

e = Probable error
BW = Effective filter bandwidth
TC = Meter time constant

E. PHASE MEASUREMENTS

An extremely useful feature of the Model 305 is its capability of supplying analogs of both the real and imaginary portions of the input signal when the specimen under test is excited by the BFO. The significance of this is, of course, that if these two dc voltages are simultaneously plotted against one another, a polar diagram will result - from which the phase response characteristics of the specimen may be determined. The information can be displayed on either an oscilloscope or an X-Y recorder and the specimen may range from a simple network to a complex electro-mechanical system. Furthermore, the testing can be performed manually or automatically depending on the setting of the sweep controls.

1. ACCURACY - No attempt has been made to normalize the phase response of the basic model 305 itself, however, the system phase shift is quite linear with frequency, (approx. 27 deg./KHz) and therefore it can be readily subtracted from the total. Another method more suitable for incremental phase measurements would be to make the desired plot using an X-Y recorder and calibrated paper, then on the same paper, plot the system phase shift. Mechanical normalization can result in accuracies of a fractional degree.

2. EXAMPLE - Consider measuring the phase response of a bandpass filter centered at 10 KHz and having a bandwidth of 1000 Hz.

   a.
   b. Calibrate the dial and zero the meter.
   c. Connect the BFO to the filter input and connect the filter output to the input terminals of the Model 305.
   d. Set the FREQUENCY dial to 10000 Hz and the

BANDWIDTH to 100 Hz.

e. Adjust the BFO to the desired level, keeping it as high as is practical.

f. Adjust the input attenuators and meter sensitivity controls such that the meter reads up-scale.

g. With no signal input, establish the X and Y axes on the paper, adjust the recorder sensitivity (j and R each = approx. 1.4V p-p for a full scale meter reading) and set the pen at the origin.

h. Connect the outputs of the Model 305 to the recorder inputs, j to X and R to Y. With the pen lifted make a dry run to check equipment connections, sensitivities, etc. The final test can then be made by scanning the spectrum of interest either manually or automatically.

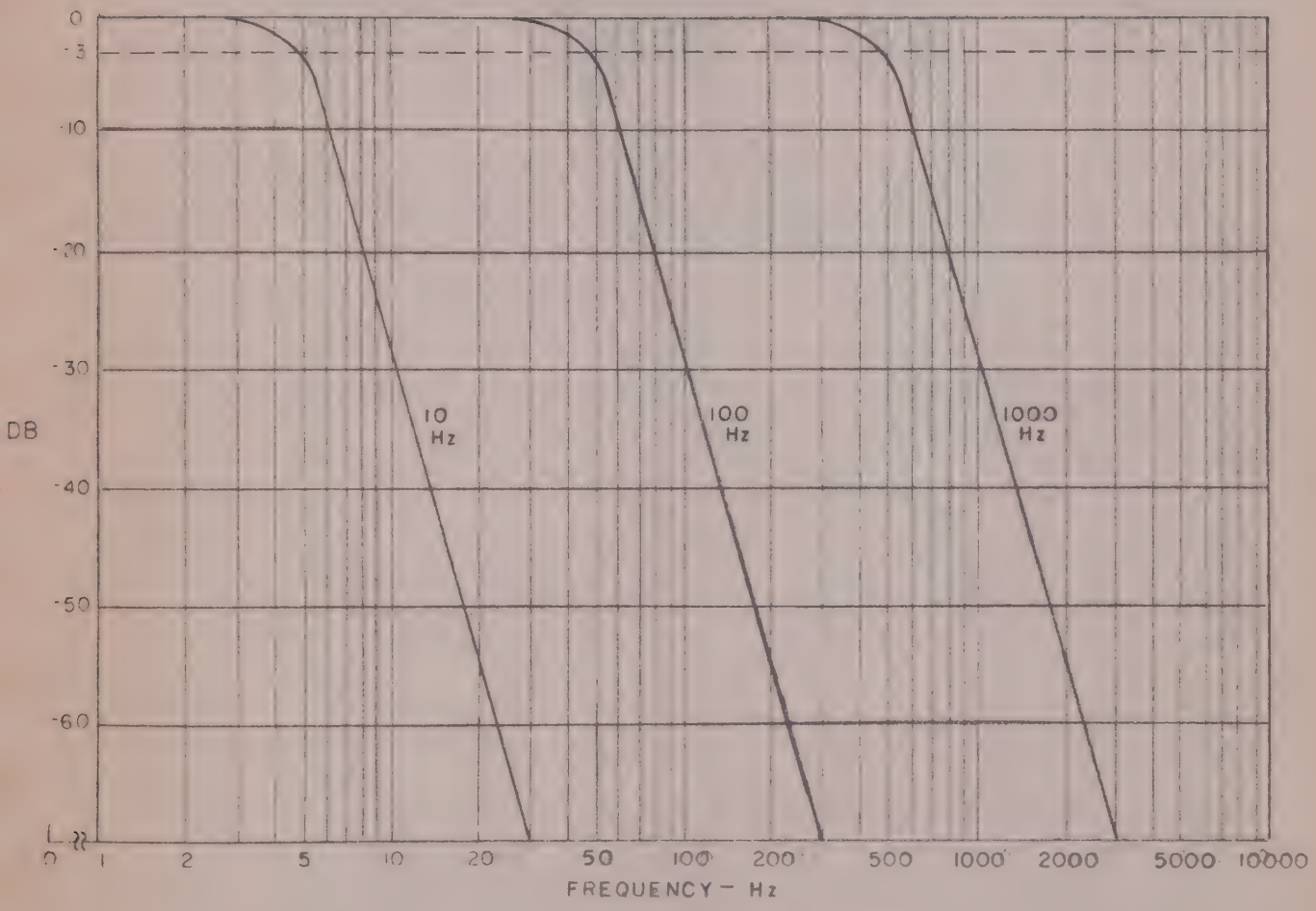


Figure 2 TYPICAL HALF-BAND RESPONSE

A. THEORY OF OPERATION

The Model 305 is basically a dual conversion hetrodyne receiver having a 100 KHz first IF and a zero center frequency second IF.

The variable oscillator is a voltage controlled oscillator producing an output variable from 100 to 150 KHz. It is extremely stable and linear, and enables the instrument to be electronically swept over its whole range by an internal ramp in the SWEEP mode. In the AFC, TRACK, and SEARCH & TRACK modes a phase detector controls the variable oscillator enabling the instrument to track a moving signal.

Referring to the block diagram, the incoming signal goes through a step attenuator, source follower and preamplifier into a low pass filter which removes frequencies above 50 KHz. The signal is then amplified and mixed with the output of the 100 to 150 KHz variable oscillator. The difference frequency is passed through the 100 KHz first IF to a pair of second modulators. The two second modulators are driven 90° out of phase by a two-phase 100 KHz crystal oscillator. The difference frequencies are then passed through a pair of four-pole maximally flat active low pass filters with selectable cutoff frequencies of 5, 50, and 500 Hz. Since the center frequency of the second IF is zero (DC), and the difference signals can go plus and minus, the resultant bandwidths are 10, 100 and 1000 Hz. The low frequency filtered signals from the two channels are then chopped at 100 KHz, again 90° out of phase, and recombined in a difference circuit. The difference signal is amplified and rectified and drives the meter and meter analog.

Phase information can be obtained from the DC outputs of the R and J channels. The R channel balanced modulator is driven from the same phase of the two-phase 100 KHz crystal oscillator as the BFO output modulator. Thus a signal from the BFO output of low enough frequency not to have phase shift introduced by the two low pass filters in the circuit will produce a DC output from the R channel, and none from the J channel, which has been chopped at 90° out of phase. If phase shift is introduced between the BFO output and the input to the first modulator, the R output will decrease and the J output increase until at 90° there will be no R output and maximum J output. In this way the Model 305 can separate the real from the imaginary parts of a voltage derived from a device driven by the BFO output.

The BFO output is a constant amplitude signal of exactly the frequency to which the instrument is tuned. It is obtained by mixing the 100 KHz fixed oscillator with the 100 to 150 KHz variable oscillator and taking the difference frequency. Unwanted higher frequency modulation products are removed by a low pass filter.

The RESTORED signal output is a filtered replica of the input signal exactly equal in frequency and proportional in amplitude. It is obtained by mixing the summed 100 KHz signal with the variable oscillator output and taking the difference frequency.

In the AFC and TRACKING modes a phase detector compares the phase difference between the third (Rø,Jø) and fourth (Rn,Jn)poles of both of the low pass filters and produces a DC voltage of proper amplitude and polarity to tune the variable oscillator so that the desired signal is in the center of the pass band. Control of the variable oscillator by the output of the phase detector is inhibited unless the signal is in excess of the threshold determined by a rear panel adjustment. Output from the phase detector is attenuated in accordance with the bandwidth, tracking range, and tracking speed in use.

B. CIRCUIT DESCRIPTION

1. ± 15 Volt Supplies, Schematic T-6301

The -15V supply has as its reference CR107 which supplies approximately 10½V positive. The error signal between ground and the mid-point of the voltage divider formed by R101, its padding resistor R102, and R103 is amplified by IC101 which drives the pass transistor Q107. Q101 is a current generator to insure that the supply will start up. The + 15V supply receives its reference voltage from the -15V supply through a voltage divider formed by R104, its padding resistor R105, and R106. The error amplifier IC102 drives the push-pull complementary pair Q104 and Q105 which in turn drive the pass transistor Q108. Q106 is a current generator to insure that the supply will start up.

2. Lamp Circuit, Schematic T-6302

The green MODE lamp DS201 lights whenever the instrument is in any mode except OFF (manual tuning). The red SWEEP lamp DS202 lights when the BANDWIDTH switch, the SWEEP SPEED switch and the SWEEP INCREMENT switch

are set to positions that would give misleading results if the instrument were used under these conditions.

3. Input, Attenuator, Preamplifier, Low Pass Filter and Post Amplifier, Schematic T-6303

The Input Step Attenuator has an input impedance of 1 megohm and is followed by Q301, an impedance converter. Q302 presents a high impedance to the source of Q301. The preamplifier IC301 drives the low pass filter which is followed by the variable gain control, which in turn drives the post-amplifier IC302.

4. First Modulator Band-Pass Filter and Step Attenuator, Schematic T-6304

The output from the post amplifier is fed to the balanced modulators Q401 and Q402. The drain of Q401 is driven through R406. The drain of Q402 is driven through R407 by phase inverter IC401. The gates of Q401 and Q402 are driven from the variable oscillator 180° out of phase by T401. The output of the balanced modulators is fed through the 100 KHz bandpass filter to the MILLIVOLTS FULL SCALE attenuator.

5. IF Amplifier and Second Modulator, Schematic T-6305

The IF Amplifier consists of amplifier Q501 which drives amplifier Q502. Q503 is the collector load for Q502 which drives the complementary pair of emitter followers Q504 and Q505. The output of the IF Amplifier drives a pair of balanced diode quadrature modulators. The modulators are driven in phase by the IF Amplifier and 90° out of phase by the quadrature outputs from the fixed 100 KHz oscillator. The difference frequencies from the two second modulators are 90° out of phase and are fed to the two low pass filters.

6. Fixed Oscillator, Phase Shift Network and Squaring Drivers, Schematic T-6306

The Fixed Oscillator is crystal controlled and consists of Q601 and Q602 which drive emitter followers Q603 and Q604. The output of Q604 goes through the MASTER-SLAVE switch to emitter follower Q605. With the MASTER-SLAVE switch in the MASTER position, the 100 KHz output is available to drive other Model 305's or Model 1305's as

as slave analyzers. When the MASTER-SLAVE switch is in the SLAVE position the crystal oscillator is disabled and the 100 KHz output from a master 305 is fed to Q605. The output of Q605 drives Q606 through a 45° lagging phase shift network consisting of R609 and C606. Q607 is driven by a 45° leading phase shift network consisting of C604 and R611 in series with R613. The 90° out of phase outputs from Q606 and Q607 are amplified and squared by I601 and I602 which in turn drive complementary pair drivers Q608, Q609 and Q610,Q611.

7. Low Pass Filters and Amplifiers, Schematic C-6307

The R and J channel filters and amplifiers are identical. Each of the filters consist of two two-pole RC active networks with capacitors selectable by the BANDWIDTH switch. The first section IC701 has a gain of approximately 50. The second section IC702 is also a two pole network having a gain of slightly more than 1. The gains of the two amplifier sections are adjusted so that the over-all response is that of a maximally flat or Butterworth filter. Separate outputs are taken from both the third (ϕ) and the fourth (N) poles of each filter. The output from the third (ϕ) pole is amplified by IC703. The phase difference between the third and fourth poles is later measured in the phase detector and used to control the variable oscillator in the AFC and TRACK modes. The gain in these channels is pre-set at the factory and should not be changed.

8. Chopper and Difference Circuits, Schematic T-6308

The outputs obtained from both the third (Rϕ,Jϕ) and fourth (Rn,Jn) of both the R and J channels are chopped at 100 KHz in the quadrature choppers Q801, Q802 and Q811, Q812. The difference between the R_n and J_n chopped outputs is taken by difference amplifiers Q803 - Q805 and Q807 - Q809. The difference between the Rϕ and Jϕ chopped outputs is taken by difference amplifiers Q804 - Q806 and Q808 - Q810. The outputs of the difference amplifiers are then filtered in 100 KHz bandpass filters.

9. Phase Detector, Schematic C-6309

The filtered outputs of the N and ϕ channels are fed to emitter followers Q901 and Q902 and are then amplified and squared by IC901 and IC902. The phase difference between the N and ϕ channels is then compared in IC903. Q903 and Q904 provide a fixed voltage for IC903. The DC output of the phase detector is filtered

and amplified in IC904 where a necessary DC offset is also introduced. The amplified DC output is then either passed or stopped by Q905 which is controlled by the threshold adjustment on the metering circuit board. The chopped and filtered difference outputs from the fourth poles (Rn,Jn) of the R and J channels are passed on to the metering circuit through the MILLIVOLTS FULL SCALE switch S-401 and the BANDWIDTH switch S202. In the 65 KHz bandwidth position the output from the post-amplifier is fed directly to the metering circuit board bypassing all intervening circuitry.

10. Meter Circuit, Schematic T-6310

The input to the meter circuit is fed to emitter follower Q1001 which drives isolation amplifier Q1002 and rectifier amplifier IC1001. The rectified output drives the threshold detector IC1002 which controls the AFC and TRACKING modes. The rectified output also feeds the meter time constant circuit which in turn drives DC amplifier IC1003. The output of IC1003 drives the meter and the meter analog, which is clamped to ground by Q1003 during retrace of the sweep or when the SWEEP MODE switch is in the RESET position.

11. Sweep Drive, Schematic T-6311

The switching functions and resistor values in this schematic are somewhat complex and need not be explained in detail. The resistance values have been optimized to give proper tracking and sweep time capabilities. The sweep driver IC1101 drives the sweep generator through the SWEEP TIME SECONDS switch in accordance with information from the phase detector and meter circuit board.

12. Sweep Generator, Schematic T-6312

The output from the sweep driver feeds the Miller integrator IC1201 which drives the timing capacitors C1204 and C1205. This timing circuit provides the proper sweep times in the SWEEP and SEARCH and TRACK modes and the proper time constant in the AFC and TRACKING modes. When the sweep voltage across the timing capacitors reaches a value equal to a reference voltage set by R1207, IC1202 is tripped discharging the timing capacitors through Q1201, provided that the SWEEP selector switch is set in the AUTOMATIC mode. If the switch is in

the SINGLE mode the sweep will merely rise to its maximum value and remain there until a RESET or AUTOMATIC mode has been set. In the RESET mode the timing capacitors will remain permanently discharged by Q-1201. The sweep and tracking lengths are controlled by the SWEEP RANGE switch S201, while the AFC tracking range is controlled by the BANDWIDTH switch S-202.

13. Impedance Converter, Schematic T-6313

The output from the sweep generator is fed to IC1301 which provides a variable reference voltage to IC1302. IC1302 also receives a differential reference voltage from the frequency control potentiometer R1315 COARSE and R1311 FINE) on the front panel. The output of IC1302 drives the variable oscillator and provides the DC frequency analog.

14. Variable Oscillator, Schematic T-6314

The variable oscillator is basically an extremely stable free-running multivibrator Q1401 and Q1407. Its frequency is controlled from the impedance converter by linearly varying the current through Q1402 and Q1408. This current varies the discharge time of the timing capacitors C1402 and C1404. Q1403 and Q1406 function as non-linear collector loads to keep the dissipation in the circuitry at a minimum. Since multivibrators are often hard to start, there is a self-starting circuit consisting of Q1404 and Q1405. The output of the multivibrator is isolated by Q1409 and amplified by push-pull complementary pair Q1410 and Q1411. The MASTER-SLAVE switch permits the Model 305 to operate other Model 305's or Model 1305's as slave analyzers, or in the SLAVE position to be operated by another Model 305. Q1412 and Q1414 are a complementary pair emitter follower drivers which drive squaring amplifiers Q1413 and Q1415.

15. BFO Restored Circuit, Schematic T-6315

The output of the variable oscillator drives the balanced modulators Q1501 and Q1502 through transformer T1501. The other input to the modulator comes from the fixed oscillator for BFO output or from the meter circuit for RESTORED output. IC1501 provides phase inversion to drive the drain of Q1502. The difference frequency is fed through the low pass filter which removes the unwanted modulation products to the output amplifier IC1502. Variable output is provided by R1518.

SECTION 4 CALIBRATION PROCEDURE

A. GENERAL

The components and transistors in the Model 305 are conservatively rated and should provide long and trouble free service. If, however, the instrument has been damaged and recalibration or alignment is required, the following instructions should be followed explicitly, or the instrument be returned to the factory. Instructions are given on the warranty page for the procedure to be followed, should it be desired to return the instrument for any reason.

Although the Model 305 is a complex instrument, trouble shooting can readily be done in sections, as indicated in the Block Diagram.

Do not change any adjustments without a thorough knowledge of the circuit and the functions of the adjustment.

Standard transistor servicing care should be used throughout. Transistors can be easily damaged with large transient voltages. Therefore, take great care not to short any terminals when making measurements on the printed-circuit boards.

In soldering to the printed-circuit boards, have the iron only hot enough to make a rapid clean solder joint. DO NOT use a solder gun. DO NOT apply any force that would tend to push the copper away from the board.

B. REMOVAL FROM CASE

1. Remove the four screws from the rear of the case.
2. Slide the instrument gently out of the front of the case.

C. CHANGING INPUT VOLTAGE

This instrument has been designed to operate from a 117 V.A.C. or a 234 V.A.C. power source. The switch on the rear of the instrument near the power cord indicates the voltage and frequency at which the instrument should be operated.

Should it be desired to change the input voltage:

1. Change the transformer primary connections by moving the switch on the rear panel to the required voltage.
2. Change the fuse. For 117 V.A.C. operation the fuse should be 1/4 amp. Slow Blow; for 234 V.A.C. operation the fuse should be 1/8 amp. Slow Blow.

SECTION 4 CALIBRATION PROCEDURE

D. CALIBRATION

1. GENERAL - The Model 305 is a precision instrument, the accuracy of which depends in a large part on critically balanced DC circuitry. The circuits in turn are designed to operate over a moderate temperature range. However, the instrument cannot cope with thermal shocks of transients, which cause differential temperatures to occur between individual components. The closed-box environment provided by the Model 305's case affords its circuits both thermal-transient and electrostatic shielding, thereby resulting in more stable operation. During calibration similar protection may be required in the interest of accuracy. It is also recommended that the new "extender boards" supplied with each instrument be used in the case of those adjustments which cannot be made without removing the circuit board. If a circuit board must be temporarily removed from its socket, or if the unit is momentarily turned off - be sure to allow the instrument time to restabilize before making further adjustments.

   Following is an outline of the set-up procedure. It is important that the adjustments be made in the prescribed order, in that some of them depend upon completion of the previous ones.

C A U T I O N

Included in this procedure are a number of adjustments which require the actual selection and installation of components. These particular adjustments are intended to be made ONLY on new assemblies or those which have received castastrophic damage necessitating a major over-haul. These components are denoted on the schematic drawings as "factory adjustments" (f. a.) and are NOT to be considered as routine adjustments.

Those adjustable controls not covered in the "Calibration Procedure" should NOT be adjusted. These are set at the factory during initial calibration and will not require further adjustment.

2. ADJUSTMENT PROCEDURE OUTLINE

   A. Frequency Determinants

      (1) Power Supplies

      (2) Variable Oscillator and Impedance Convertor

      (3) Fixed Oscillator

      (4) Sweep Circuits

SECTION 4 CALIBRATION PROCEDURE

2. B. Signal Channel

   (1) Meter Zero Adjustments

   (2) R/J Channel Balance

   (3) Calibrate Gain Circuit

   (4) Check Systems Gain

3. TEST EQUIPMENT REQUIRED

1.	VOM	Avometer or equivalent 20,000 Ohm/Volt
2.	D. C. VOLTMETER	0.05% Accuracy
3.	OSCILLATOR	10Hz to 100KHz. 1 Volt Out
4.	VTVM	HP 400D or Equivalent
5.	OSCILLOSCOPE	Tektronix 503 or Equivalent
6.	OSCILLOSCOPE	50MHz response with low-capacitance probe.
7.	FREQUENCY COUNTER	Range 500KHz Accuracy 0.1%
8.	DECADE ATTENUATOR	G.R. 1450 or Equivalent

4. INITIAL SETTING OF CONTROLS

METER ZERO CONTROLS	_	MID RANGE
METER T. C.	_	.1
MILLIVOLTS FULL SCALE	_	1000
BANDWIDTH	_	1000Hz
FREQUENCY DIAL	_	00.00
ZERO CONTROL	_	MID RANGE (10 TURN POT)
METER MULTIPLIER	_	X 1

SECTION 4 CALIBRATION PROCEDURE

VARIABLE CONTROL	–	"CALIBRATED"
"MODE" SWITCH	–	OFF
SWEEP RANGE	–	50KHz
SWEEP TIME	–	0.5 SECONDS
SWEEP FUNCTION	–	RESET
BFO-RESTORED	–	BFO
VARIABLE CONTROL	–	FULLY CLOCKWISE
REAR PANEL SWITCHES	–	MASTER/SLAVE TO MASTER, BOTH SWITCHES TO LEFT

Allow instrument to warm up for 15 minutes, before attempting the following procedures:

5. CALIBRATION OF FREQUENCY CONTROL CIRCUITS

(A) Power Supplies Assembly #6140, Test Equipment Items: #2

1. Monitor the minus 15 volt line with D.C. voltmeter connected between purple lead on Q107 and ground. Should read minus 15 volts ± 150 millivolts. If necessary select R102 for correct reading.

2. Monitor the plus 15 volt line between red lead on Q108 and ground should read plus 15 volts ± 200 millivolts. If necessary select R105 for correct reading. Should R102 or R105 require adjustment of more than 20%, circuit should be investigated for faulty component.

(B) Variable Oscillator Assembly #6144, Impedance Convertor Assembly #6143, Front Panel Controls as in "Initial Setting" test equipment items: #2 and #7.

1. Monitor the variable oscillator frequency at TP1401 (BNC on rear panel) with frequency counter. Frequency should be 100KHz ± 250Hz. If necessary adjust R1406 for correct frequency. Adjust front panel "Zero" for exactly 100KHz, if R1406 is adjusted, allow circuit time to regain thermal stability before rechecking.

2. Monitor frequency analog at J101, Pin 7 with D. C. voltmeter for zero volts ± 1 millivolt. If necessary adjust R1303 for correct reading.

3. Turn main tuning dial to exactly 50KHz. Check counter reading for 105KHz ± 200Hz, adjust R1307 if required.

4. D. C. voltmeter ~~should~~ now read 5 volts ± 50 millivolts, If necessary adjust R1311, R1406, R1303 and R1307 are factory selected and should not require adjustment in normal calibration procedure.

5. Check the linearity of the frequency dial and the frequency analog over the instruments. Full frequency range and compromise the preceding tolerances to obtain an overall frequency accuracy within ± 0.5%.

(C) Fixed Oscillator Assembly #6132, Test Equipment item: #6 and #7. Check fixed oscillator frequency at test socket (BNC on rear panel) with frequency counter. Frequency should be 100KHz ± 10Hz. This is a crystal controlled oscillator and no adjustment is available. This test is to check for malfunctions only. Connect oscilloscope via low capacitance probe to the junction of Cable #36 and resistor on rear section of the Bandwidth Switch, adjust R526, (top potentiometer on rear baseboard situated between sections 6132 and 6133) for minimum 100KHz signal on scope display. Connect probe to the junction of Cable #34 and resistor on second section of the bandwidth switch, adjust R527 (lower potentiometer on rear baseboard situated between sections 6132 and 6133) for minimum 100KHz signal on scope display.

(D) Sweep Circuit Assembly #6142, Front Panel Controls as "Initial Setting" except Mode Switch to "Sweep". Test equipment items: #2 and #7.

1. Connect frequency counter to variable oscillator output TP1401 (BNC on Rear Panel) connect D. C. voltmeter to J101, Pin #1. Frequency should be 100KHz. adjust front panel zero control for correct reading. Sweep analog should read zero volts. Switch sweep function to "Single" sweep. At completion of sweep (0.5 seconds). Sweep analog should read 5 volts ± 50 millivolts. Adjust R1207 if necessary. Variable oscillator should read ~~150KHz~~ ± 5%.

2. Check sweep ranges for designated widths within ± 5%

NOTE: For small sweep widths, ensure that variable oscillator is exactly 100KHz with the sweep function in reset.

3. Check sweep time as designated within ± 10%.

NOTE: Since the sweep circuit generates a very linear ramp voltage (0 - + 5 Volts) the total ramp time may be extrapolated by measuring only a portion of the total sweep voltage, perhaps 1 or 2 volts.

6. CALIBRATION OF THE SIGNAL CHANNEL

Front panel controls as in "Initial Setting" except: Tune main frequency dial to 10KHz and set Millivolts Full Scale Switch to 3.

(A) METER ZERO In order to obtain both the required range and resolution of the meter zero controls, it is necessary to have both coarse and fine adjustments for each channel. With front panel meter zero controls at mid range. Adjust the Rn and Jn potentiometers situated at the top of the rear baseboard, for minimum meter indication. Adjust front panel meter zero controls for final balance.

(B) R/J CHANNELL BALANCE When the gain and phase response of the "R" and "J" channels are properly adjusted, meter ripple can be held to less than 5%. Front panel controls in "Initial Setting" test equipment items: #3, #4 and #5. Apply a 10KHz signal at 1 volt to the input of the input of the Model 305. Tune frequency dial to the input frequency. If meter ripple is less than 5% no further adjustment is necessary, if greater than 5% proceed with the following:

1. Connect Rn test point (top of rear baseboard) to the horizontal input of oscilloscope, input mode D.C. connect "Jn" test point (top of rear baseboard) is the vertical input of oscilloscope, input mode D.C. Adjust "X" and "Y" sensitivities to 0.2 millivolts/cm.

2. Adjust R-j phase control or rear baseboard to obtain a circular lissajou pattern on the oscilloscope. If meter ripple is still greater than 5% proceed.

3. Connect oscilloscope probe to "N"CHANNEL OUT" test point on top of rear baseboard. Set oscilloscope horizontal to 10 milliseconds/cm. Set oscilloscope vertical to 100 millivolts/cm and adjust to view the lower edge of the display.

4. Tune the Model 305 frequency dial a few cycles away from the input signal of 10KHz. to view the ripple appearing on the oscilloscope display. Adjust front panel "METER ZERO" controls for minimum ripple on scope display. Adjust lower potentiometer on rear baseboard (inside chassis between sections 6135 and 6136) slightly clockwise, Rebalance front panel "METER ZERO" controls and check for reduction in ripple. If no improvement, adjust the lower potentiometer counter-clockwise and rebalance "METER ZERO" controls.

5. Connect oscilloscope probe to " Ø OUT" test point on top or rear baseboard. Set oscilloscope horizontal to 10 milliseconds/cm. Set oscilloscope vertical to 100 millivolts/cm and adjust to view lower edge of the display. Tune the Model 305 frequency dial a few cycles away from the input signal of 10KHz to view the ripple appearing on the oscilloscope display. Adjust jØ and RØ potentiometers on top of rear baseboard for minimum ripple on scope display. If ripple is greater than 6% of display adjust the top potentiometer on rear baseboard, (inside chassis between sections 6135 and 6136) and rebalance the JØ and RØ potentiometers to minimize ripple.

(C) PHASE DETECTOR CALIBRATION Connect Rn test point (top of rear baseboards) to the horizontal input of oscilloscope input mode-D.C. connect jN test point (top of rear baseboard) to the vertical input of oscilloscope, input mode-D.C., adjust "X" and "Y" sensitivities to 0.2 millivolts/cm. Apply 10KHz signal 1 volt amplitude to Model 305 input and tune Model 305 frequency dial to obtain a circular lissajou pattern. Set sweep mode switch to "AFC" sweep time to .5 seconds. Sweep range to 50KHz sweep function to reset. Switch sweep function to "SINGLE". Signal should phase lock (lissajou pattern is replaced by single spot on display in arc of the lissajou figure). If this does not occur, adjust phase detector balance potentiometer (top of rear baseboard) and operate sweep function switch between "RESET" and "SINGLE" until phase lock pattern occurs.

(D) SYSTEM GAIN CALIBRATION Front panel control as in initial setting. Calibrate the gain of the overall system by applying a 1KHz signal of an exact 1 volt amplitude to the input. Tune frequency dial to 1KHz. Adjust "CAL GAIN" control on rear panel for full scale readings on front panel meter. Switch Bandwidth switch to "65KHz." position, adjust potentiometer on the rear section of the Bandwidth switch for exactly "FULL SCALE" reading on front meter. Increase input frequency to 50KHz. Model 305 remains tuned to 1KHz. Adjust C311 on the "METER MULTIPLIER" switch for full scale meter reading. Change "METER MULTIPLIER" to X .1 position and adjust input signal to 100 millivolts. Adjust C302 for full scale meter reading.

SEMICONDUCTOR LEGEND

Changes and improvements in the semiconductor products available for commercial use necessitate type changes from time to time. To eliminate confusion and costly paperwork, many of these changes will be covered in the following legend. The purpose of this legend is to acknowledge the fact that the type number on a semiconductor found in a piece of equipment will not necessarily correspond with the type number given on the schematic diagram.

The legend is not intended to be an interchangeability list although in many cases good quality components* within a given category may be substituted with acceptable results. Normally, replacements should be made using components having the same type number as the component being replaced.

Those components bearing an asterisk on the schematic diagram are factory selected components and should be obtained from Quan-Tech Laboratories.

*It should be noted that the incoming inspection procedure followed at Quan-Tech Laboratories includes noise screening on most semiconductors.

TYPE # ON SCHEMATIC	TYPE # IN EQUIPMENT
T1480	2N1613
T1494	2N1613
1N703	1N748
1N709	1N753
1N2859	1N3253, 1N3254
1N2862	1N3254
1N482A	1N3604
1N3253	75A4
1N3254	75A4
2N396A	4JX1G759, 4JX1D653, 2N3644
2N414	2N396A, 4JX1G759, 4JX1D653, 2N3644
2N929	2N0N2, A642, 2N3566, A322, A324
2N1515	2N3644
2N1613	2N3566, 2N3643
2N2219	220N2, A642, 2N3566, A322, A324
2N2603	2N3250
2N3250	2N3644
2N270	2N3644
2N1306	2N3566
2N1304	2N3566
2N3250	2N3251
UC240	2N4869, 2N3819
2N3644	2N3250, 2N3251
2N3566	2N3643

SCHEMATIC LEGEND

k = 1000

⊘ = Screw Driver Adjustment

▭ = Front Panel Control

* = Factory Select

Unless Otherwise Specified:

All Resistances in Ohms

All Resistors 1/2 Watt

All Capacitances in Microfarads

8/20/69

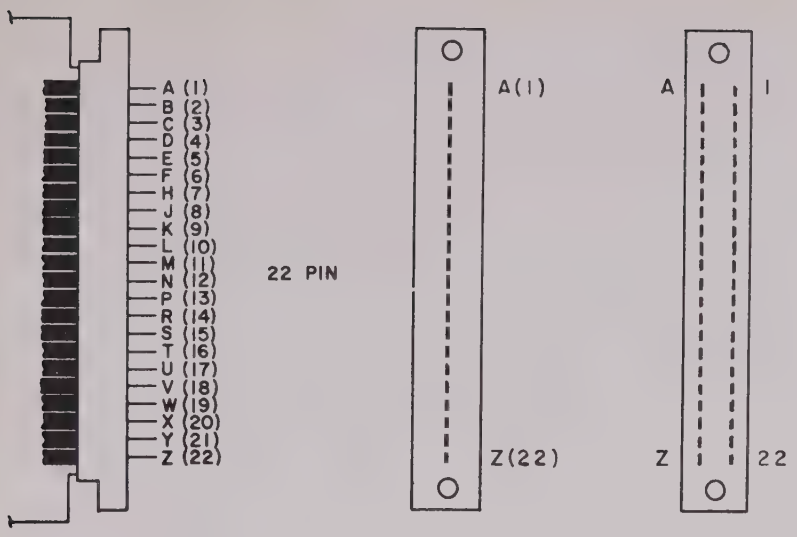


FIG. 1 PRINTED CIRCUIT BOARD LUG IDENTIFICATION

Fig. 1 illustrates the identification and orientation of a printed circuit board and connector utilizing 22 pins.

When a printed circuit board of a lesser number of pins is called for, the same designating sequence shall apply.

When a single sided copper P.C. Board is used, its pin identification shall be as shown in Fig. 1, and its schematic references shall be A(1), B(2), C(3) etc. The copper side faces the observer when viewed as shown at the left.

When using a double sided copper P.C. Board, its pin orientation shall be as shown in Fig. 1 and its schematic references shall be as follows:

a. (A), (B), (C) etc. signifies that electrical connections are made to lettered side of P.C. Board (A side).

b. (1), (2), (3) etc. signifies that electrical connections are made to numbered side of P.C. Board (1 side).

c. A(1), B(2), C(3) etc. signifies that electrical connections are made to both sides of P.C. Board simultaneously, i.e., A and 1 are schematically connected.

MILLIVOLTS FULL SCALE

METER MULTIPLIER

INPUT

STEP ATTEN.

PRE-AMPL. PT. OF BOARD ASSY. # 6146

NORMAL

PHASE

65 KHz LOW PASS FILTER 6082

VAR. GAIN

VAR. ATTEN.

POST AMPL. PT. OF BOARD ASSY. # 6146

1ST MODULATOR PT. OF BD. ASSY. 6145

100 KHz BAND PASS FILTER 6081

STEP ATTEN.

I.F. AMPL. BD. ASSY. 6131

BFO

RESTORED

BALANCED MODULATOR PT. OF BD. ASSY. 6141

65 KHz LOW PASS FILTER PT. OF BD. ASSY. # 6141

VAR. PT. OF BOARD ASSY. # 6141

BFO RESTORED OUT

FREQ. ZERO

FREQ. (+) IN KHz

RANGE ΔF

TIME

MASTER

SLAVE

VAR. OSC. 100-150 KHz BD. ASSY. # 6144

IMPEDANCE CONVERTER BD. ASSY. # 6143

SWEEP GENERATOR PT. OF BD. ASSY. # 6142

AFC

TRACK

SEARCH & TRACK

SWEEP

OFF

VAR. SLAVE IN

VAR. MASTER OUT

FREQ. ANALOG

SWEEP ANALOG ALSO AFC ANALOG TRACK ANALOG

GAIN FUNCTIONS IN ACCORDANCE WITH MODE, BANDWIDTH, TRACK RANGE, AND TRACK SPEED.

+15 VOLT SUPPLY PT. OF BD. ASSY. # 6140

-15 VOLT SUPPLY PT. OF BD. ASSY. # 6140

LAMP CIRCUIT

BALANCED MODULATOR PT. OF BD. ASSY. # 6133

SELECTABLE BANDWIDTH 4 POLE LOW PASS FILTER BD. ASSY. # 6135 BD. ASSY. # 6128(2)

1 2 3 4

R CHANNEL

R CHANNEL OUT

FIXED MASTER OUT

0°

100 KHz 2 PHASE CRYSTAL OSC. BD. ASSY. # 6132 PT. OF BD. ASSY. # 6133

90°

FIXED SLAVE IN

R CHOPPER PT. OF BD. ASSY. # 6136

DIFFERENCE CIRCUIT PT. OF BD. ASSY. # 6136

J CHOPPER PT. OF BD. ASSY. # 6136

BALANCED MODULATOR PT. OF BD. ASSY. # 6133

1 2 3 4

SELECTABLE BANDWIDTH 4 POLE LOW PASS FILTER BD. ASSY. # 6134 BD. ASSY. # 6128(2)

J CHANNEL OUT

J CHANNEL

PHASE DETECTOR BD. ASSY. # 6137

R CHOPPER PT. OF BD. ASSY. # 6136

DIFFERENCE CIRCUIT PT. OF BD. ASSY. # 6136

J CHOPPER PT. OF BD. ASSY. # 6136

STEP ATTEN.

VAR. ATTEN.

AFC & TRACK THRESHOLD ADJ.

METER T.C. SECONDS

BROAD BAND #2 KHz

10 100 1000 Hz

METER CIRCUIT BD. ASSY. # 6138

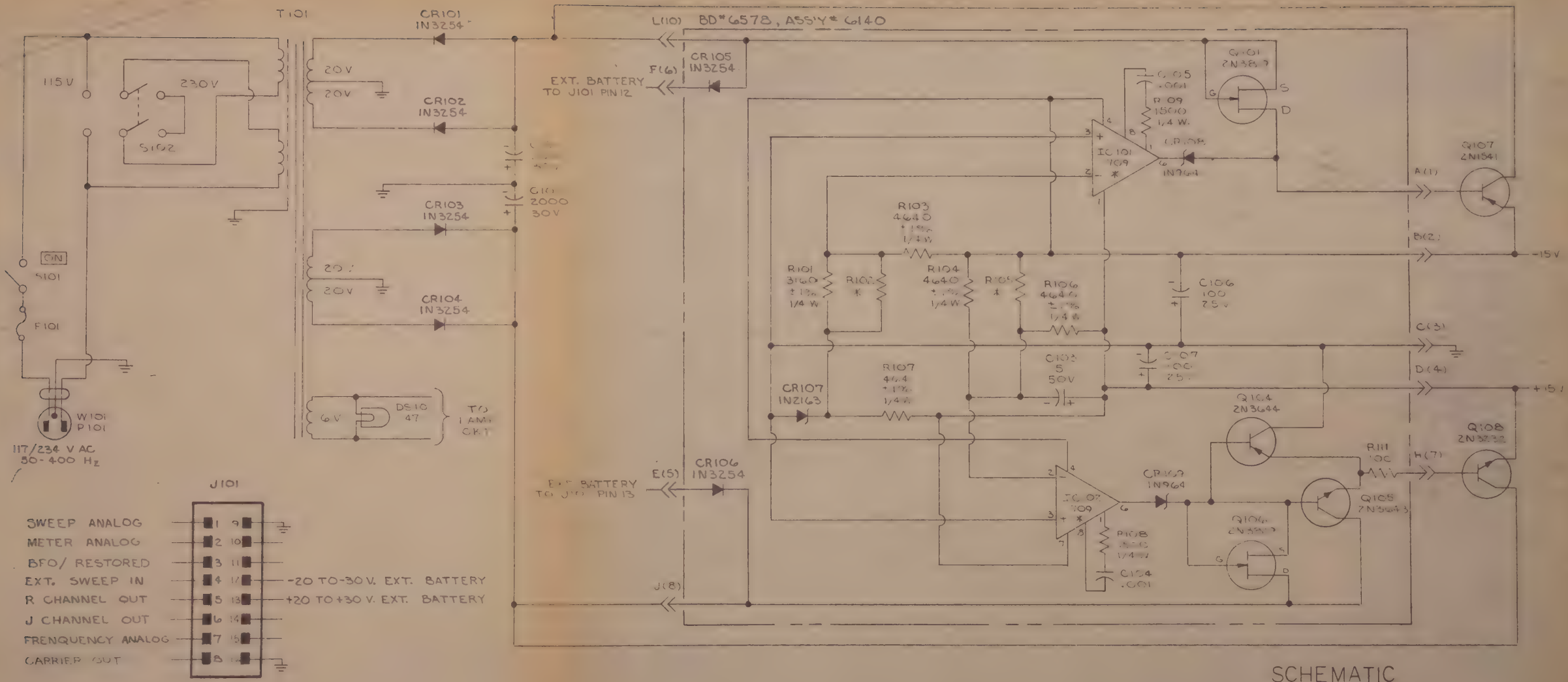
METER ANALOG

-90° PHASE SHIFT NETWORK

CARRIER OUT

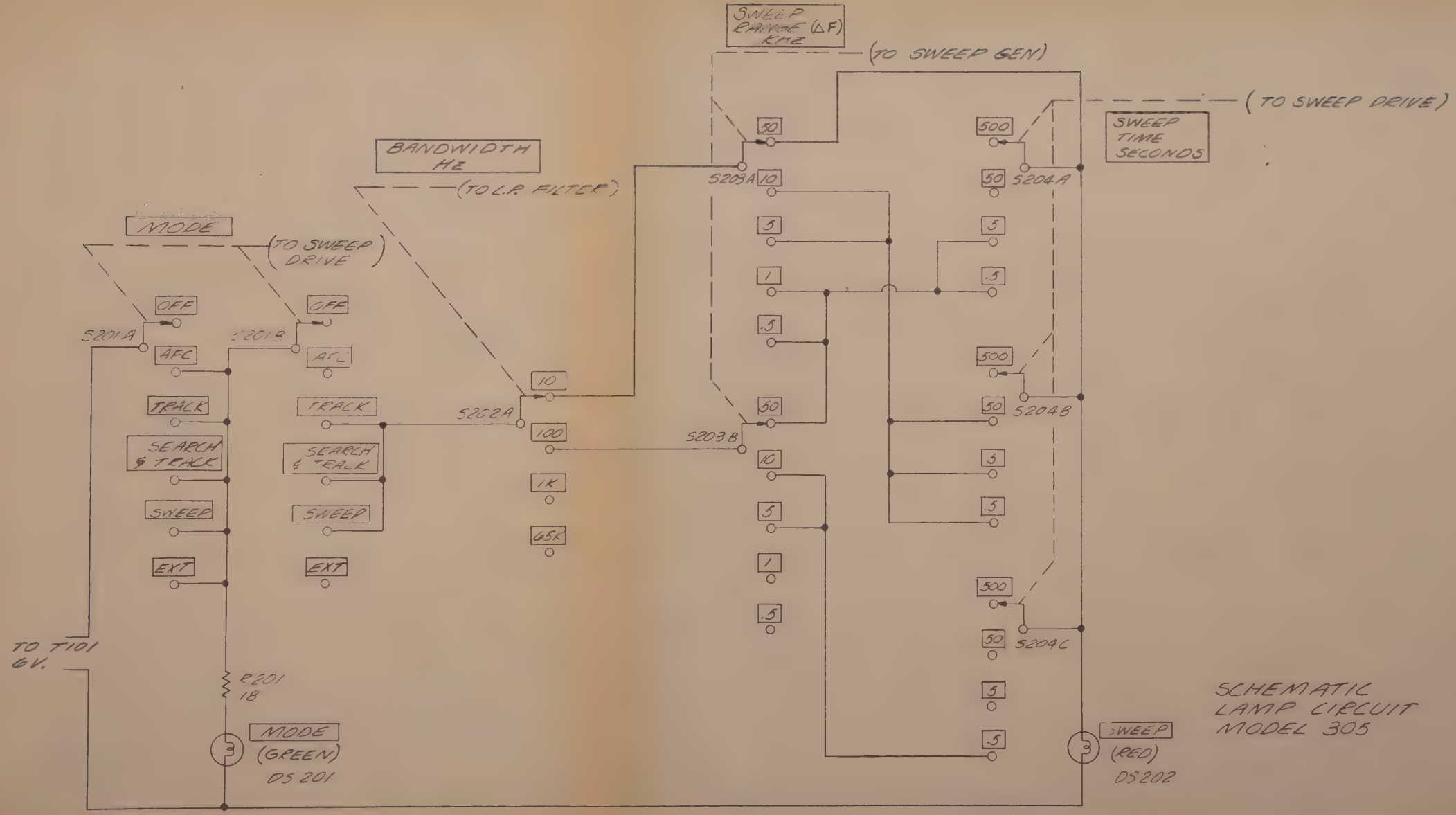
BLOCK DIAGRAM
MODEL 305

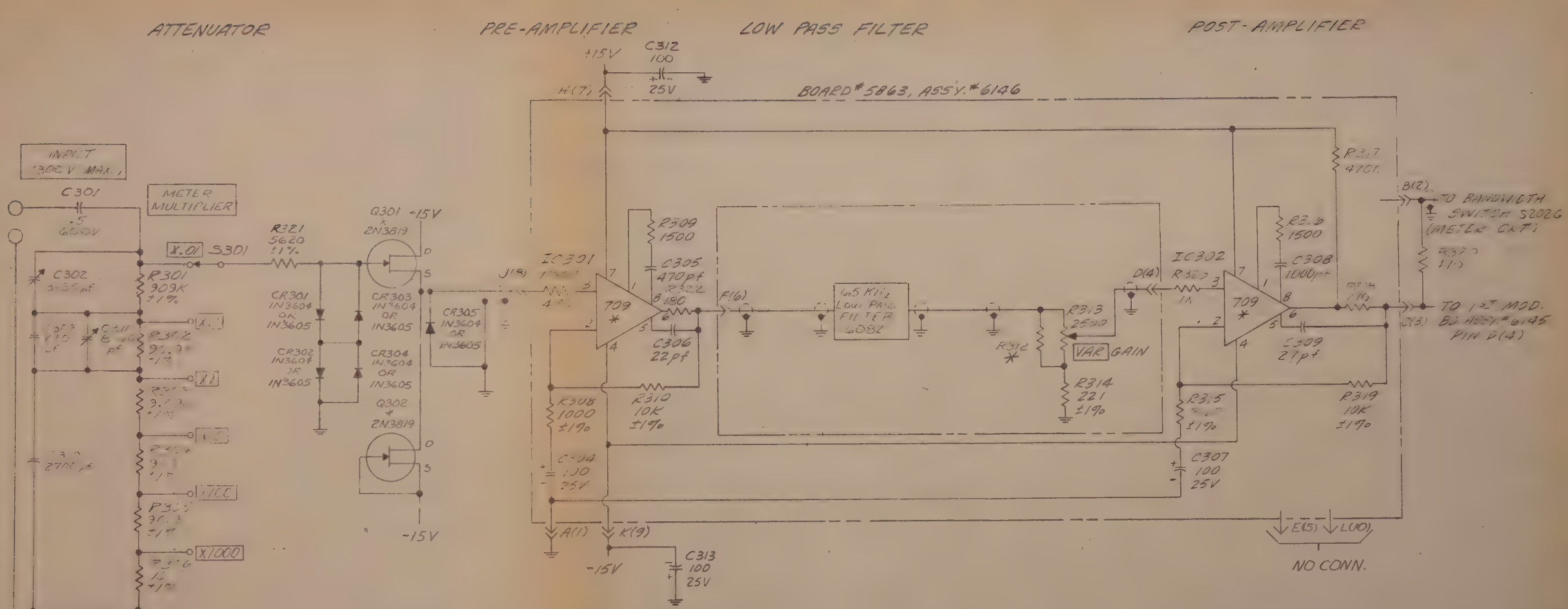
D-6300-A



SCHEMATIC
POWER SUPPLY
MODEL 305

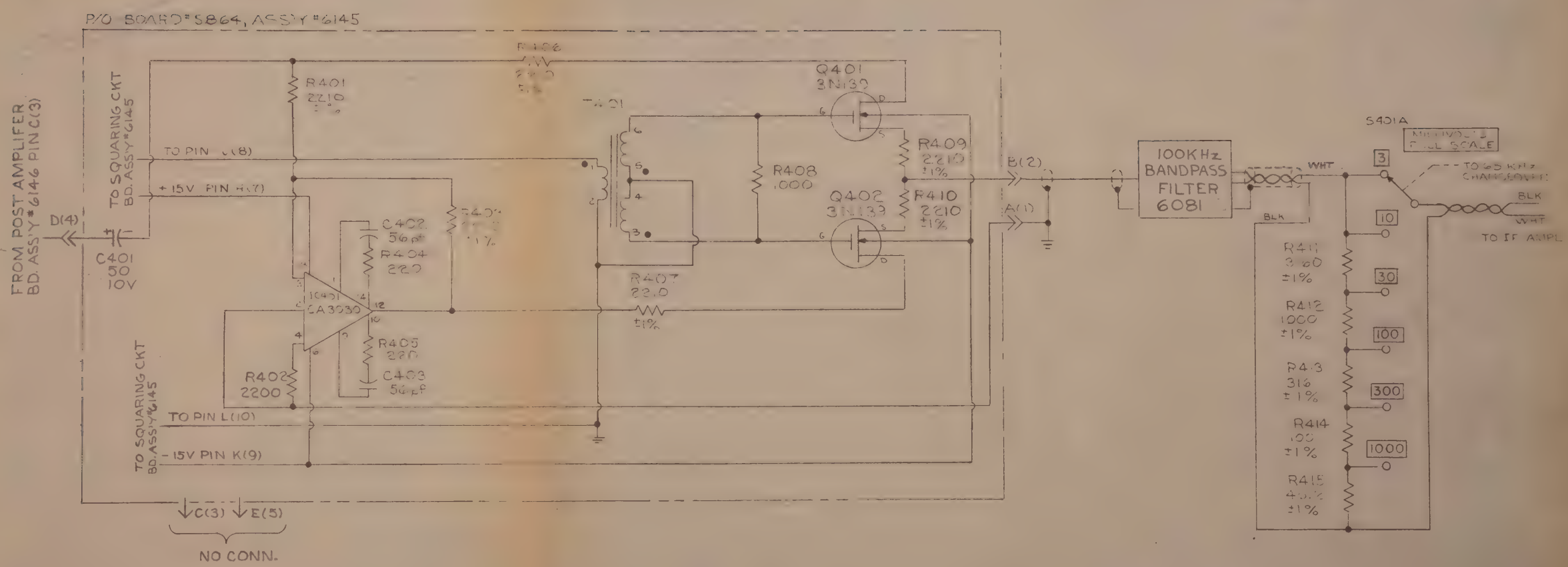
T-6301-D


SWEEP RANGE (ΔF) KHz
(TO SWEEP GEN)
(TO SWEEP DRIVE)
SWEEP TIME SECONDS
BANDWIDTH Hz
(TO L.P. FILTER)
MODE
(TO SWEEP DRIVE)
S201A
S201B
OFF
AFC
TRACK
SEARCH & TRACK
SWEEP
EXT
S202A
10
100
1K
65K
S203A
S203B
30
10
3
1
.3
50
S204A
S204B
S204C
500
50
5
.5
TO T101 6V.
R201 18
MODE (GREEN) DS 201
SWEEP (RED) DS202
SCHEMATIC LAMP CIRCUIT MODEL 305
T-6302-B



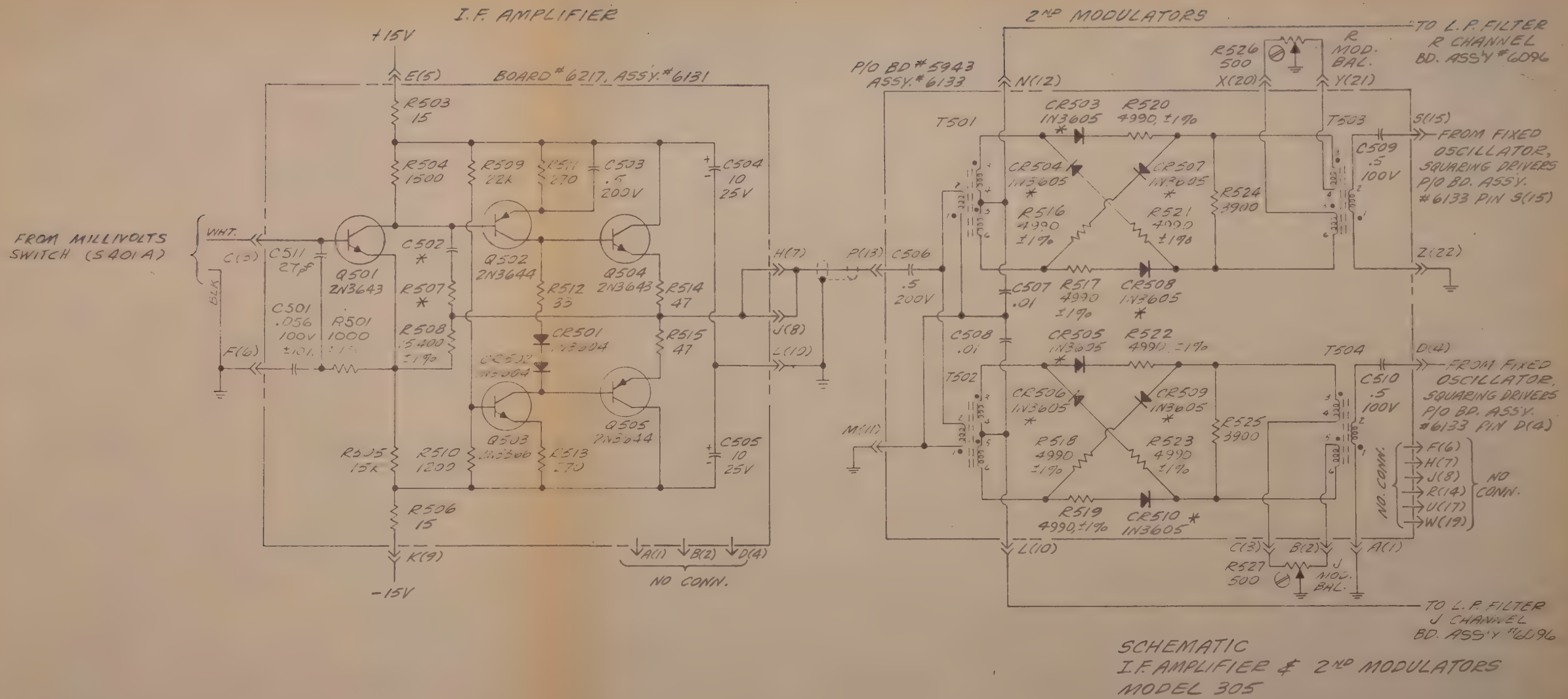
SCHEMATIC
INPUT, ATTENUATOR, PRE-AMPLIFIER,
LOW PASS FILTER AND POST-AMPLIFIER
MODEL 305

T-6303-D



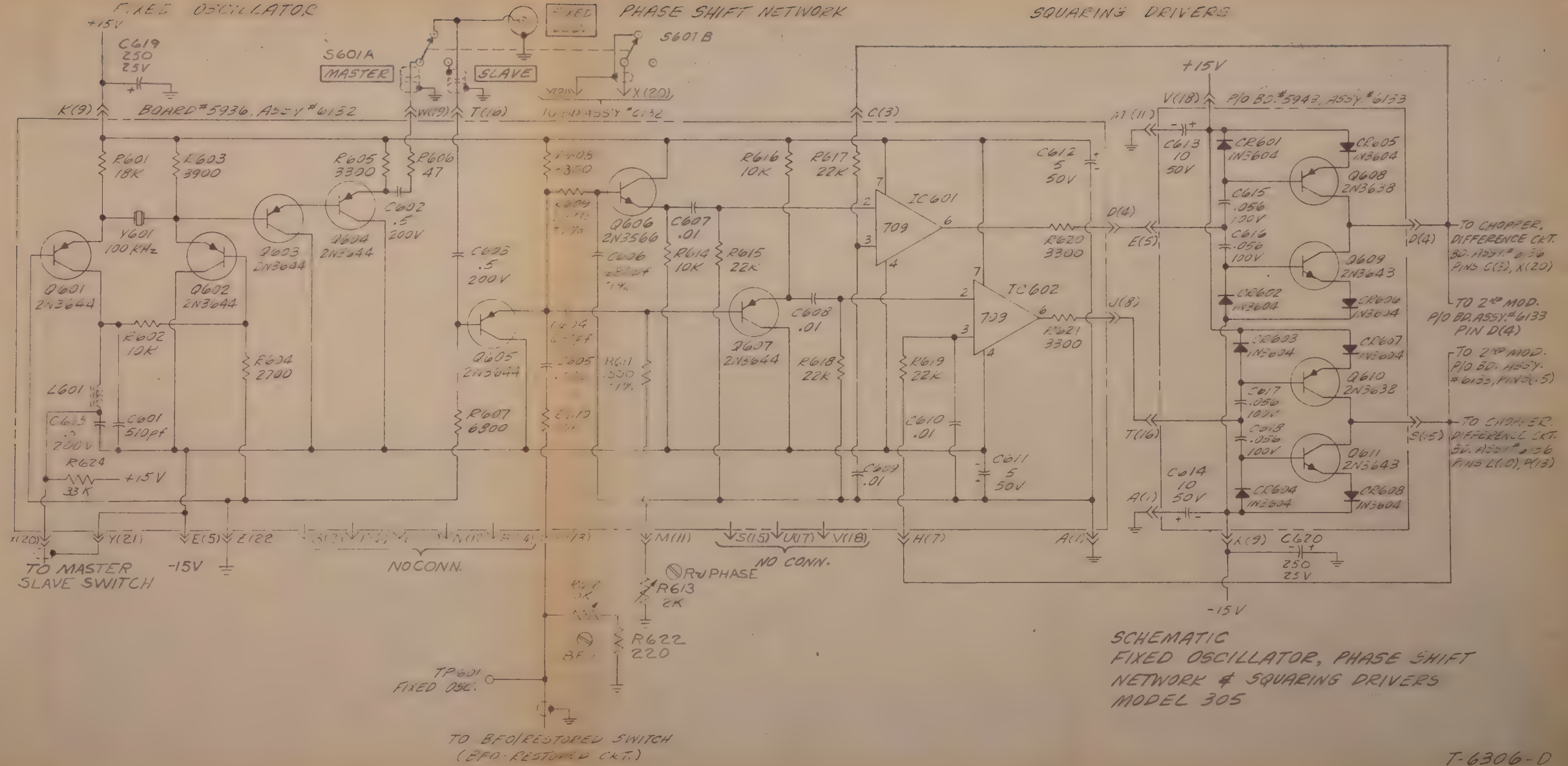
SCHEMATIC
1ST MODULATOR, BAND PASS FILTER
AND STEP ATTENUATOR
MODEL 305

T-6304-D



SCHEMATIC
I.F. AMPLIFIER & 2ND MODULATORS
MODEL 305

T-6305-C



SCHEMATIC
FIXED OSCILLATOR, PHASE SHIFT
NETWORK & SQUARING DRIVERS
MODEL 305

T-6306-D

R CHANNEL, LOW PASS FILTER & AMPLIFIERS

BOARD # 5868, ASSY. # 6135

R CHANNEL METER ZERO — R702 1000

+15V — K(9) — J(8) — V(18)

C701 .01 — R703 22.1K ±1% — R701 221 ±1% — R704 3010 ±1% — R707 68.1K ±1%

IC701 709 * — R709 158K, ±1% — C702 560pf — R710 1500 — R711 100 — C703 330pf — R712 2370 ±1% — R713 100 ±1% — R708 8250 ±1%

C704 10 50V — C705 10 50V

IC702 709 — R715 49,900 ±1% — R714 100K ±1% — C706 .005 — R716 15,400 ±1% — R717 1500 — R718 2.2K — C707 220pf — C708 .1 100V — R741 1K

R719 604 ±1% — R720 4040 ±1% — R722 3160 ±1% — R723 10K R∅ — -15V

IC703 709 — R724 18.2K ±1% — R721 100K ±1% — C709 .005 — R725 15,400 ±1% — R726 1500 — R727 2.2K — C710 220pf — C711 .1 — R742 1K

TP 701 R∅ — R728 4700 — (R-J) ∅ BAL. R729 5000 — TO CHOPPER DIFFERENCE BD. ASSY. # 6136, PIN Y(21) — Z(22)

R(14) — L(10) — M(11) — B(2) — S(15) — T(16) — C(3) — A(1) — E(5) — Y(21) — W(19) — X(20) — D(4) F(6) H(7) N(12) P(13) U(17) NO CONN.

R706 5K — R705 20K ±1% — -15V

BD. # 5867, ASSY # 6096

FROM 2ND MODULATOR BD. ASSY # 6133, PIN N(12)

R730 27K ±1% — R731 27K ±1%

C712 .01 100V — C713 .1 100V — C714 1 100V — C715 .01 100V — C716 .1 100V — C717 1 100V

65K — 1K — 100 — 10 — 65K — 1K — 100 — 10

S202B — S202C

BD. # 5867 ASSY. # 6069

R730 27K ±1% — R731 27K ±1% — C712 .01 100V — C713 .1 100V — C714 1 100V — C715 .01 100V — C716 .1 100V — C717 1 100V

65K — 1K — 100 — 10 — 65K — 1K — 100 — 10

S202D — S202E

TP 702 RN — RN CHANNEL OUT TO J101, PIN 5 — R734 4700 — (R-J) N BAL. R735 5000 — TO CHOPPER DIFFERENCE BD. ASSY. # 6136, PIN B(2)

BANDWIDTH Hz

(TO LAMP CIRCUIT) — (TO PHASE DETECTOR)

J CHANNEL, LOW PASS FILTER & AMPLIFIERS

BOARD # 5868, ASSY. # 6134

+15V — R736 1000 — J CHANNEL METER ZERO — K(9) — J(8) — V(18)

SAME AS R CHANNEL

TO 65 KHz CHANGEOVER

R(14) — L(10) — M(11) — B(2) — S(15) — T(16) — C(3) — A(1) — E(5) — Y(21) — W(19) — X(20) — Z(22)

R737 10K JN — -15V — R738 10K J∅ — -15V

FROM 2ND MODULATOR BD. ASSY # 6133, PIN L(10)

BD. # 5867 ASSY. # 6096 — SAME AS R CHANNEL

BD. # 5867 ASSY. # 6069 — SAME AS R CHANNEL

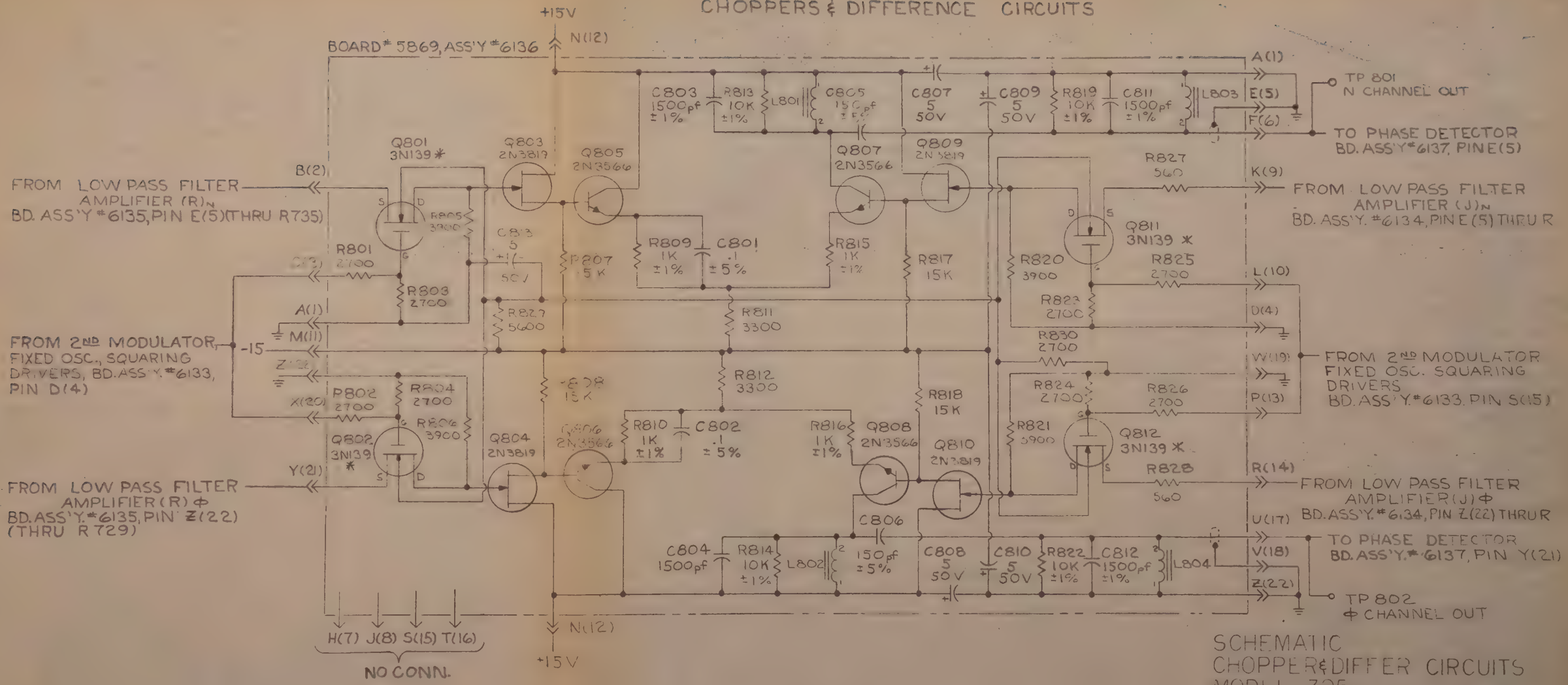
TP 703 J∅ — R739 4700 — TO CHOPPER DIFFERENCE BD. ASSY. # 6136, PIN R(14)

TP 704 JN — J CHANNEL OUT TO J101, PIN 6 — R740 4700 — TO CHOPPER DIFFERENCE BD. ASSY. # 6136, PIN K(9)

SCHEMATIC
LOW PASS FILTERS & AMPLIFIERS
MODEL 305

C-6307-E

CHOPPERS & DIFFERENCE CIRCUITS



SCHEMATIC
CHOPPER & DIFFER CIRCUITS
MODEL 305

T-6308-D

PHASE DETECTOR

65K CHANGEOVER

BD*5876, ASS'Y*6137

+15V C912 10 50V

FROM CHOP. DIFF. CKT. BD. ASS'Y*6136, PIN U(11)

Q901 2N3960A

Q902 2N3960A

R905 2.2K

R902 2.2K

R903 2.2K

R906 2.2K

T901

T902

CR901 CR902 CR903 CR904 IN3604

CR905 CR906 CR907 CR908 IN3604

IC901 CA3030

IC902 CA3030

IC903 MC790

R907 2.2K

R908 2.2K

R913 2.2K

R914 2.2K

CR909 CR910 CR911 CR912 IN3604

CR913 CR914 CR915 CR916 IN3604

Q903 2N3644

Q904 2N3644

R916 22.1K ±1%

R917 22K

R918 2K

C911 10 50V

R919 1K ±1%

R920 1K ±1%

C905 470pF

R924 49.9K * ±1%

C906 10 pF

C904 1.0 100V

R921 100

R922 1.82K ±1%

C908 .01

C907 150pF

R923 1.5K

R925 100

R926 2200

Q905 2N1304

R936 8200 1/4W

C909 .01

R928 38.6

R929 5K PHASE DET BAL

R930 2.2K

T(16)

M(11) -15V

C(3) (TO LP. FILTER)

A(1)

Z(21)

B(2) F(6) H(7) K(9) L(10) P(13) R(15) S(15) X(20) 1:10 CONN.

J(8) TO MODE SWITCH (SWEEP DRIVE)

D(4) FROM METERING CKT BD.ASS'Y* 6138 PIN L(10)

BANDWIDTH Hz

(TO SWEEP DRV.)

10 100 S402G 1K 65K

R931 10K

MILLIVOLTS FULL SCALE

TO STEP ATTN

3 S401B

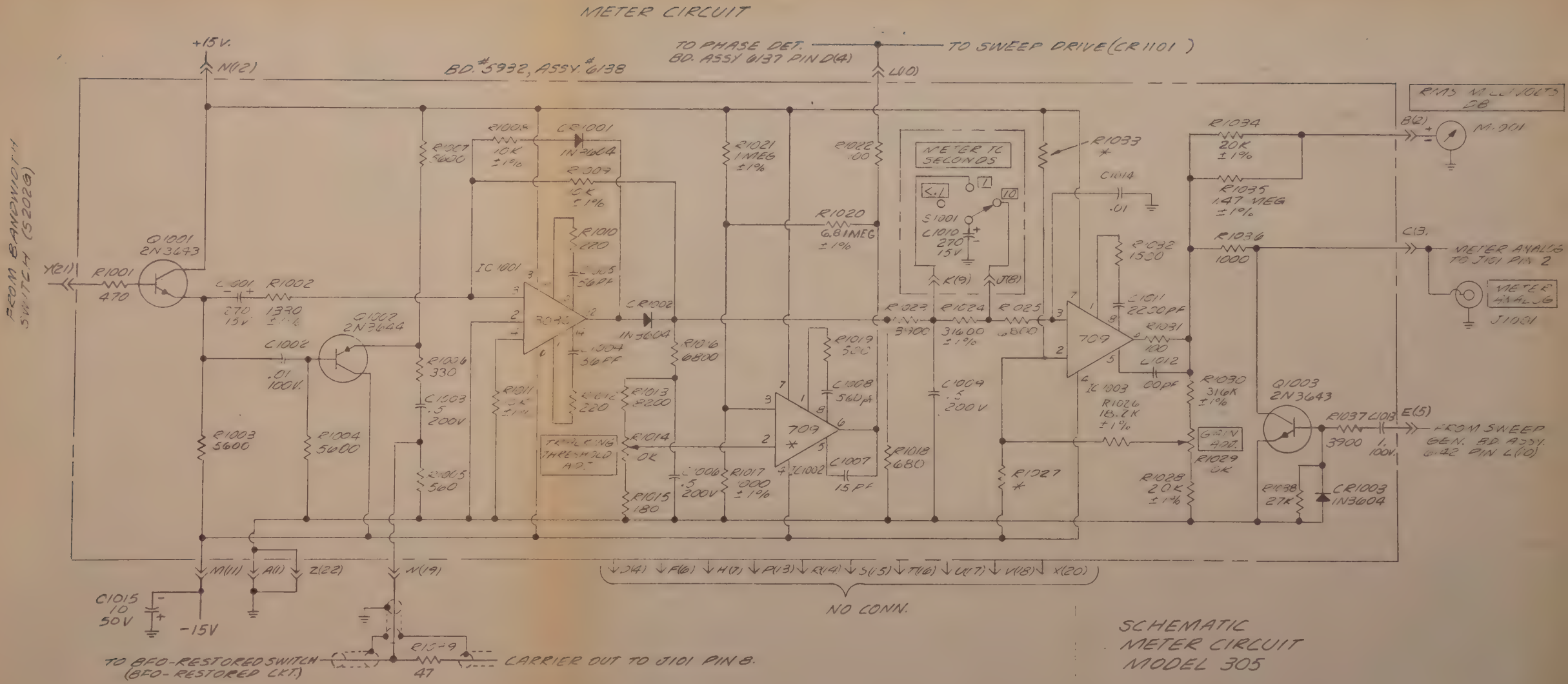
R932 ±1%

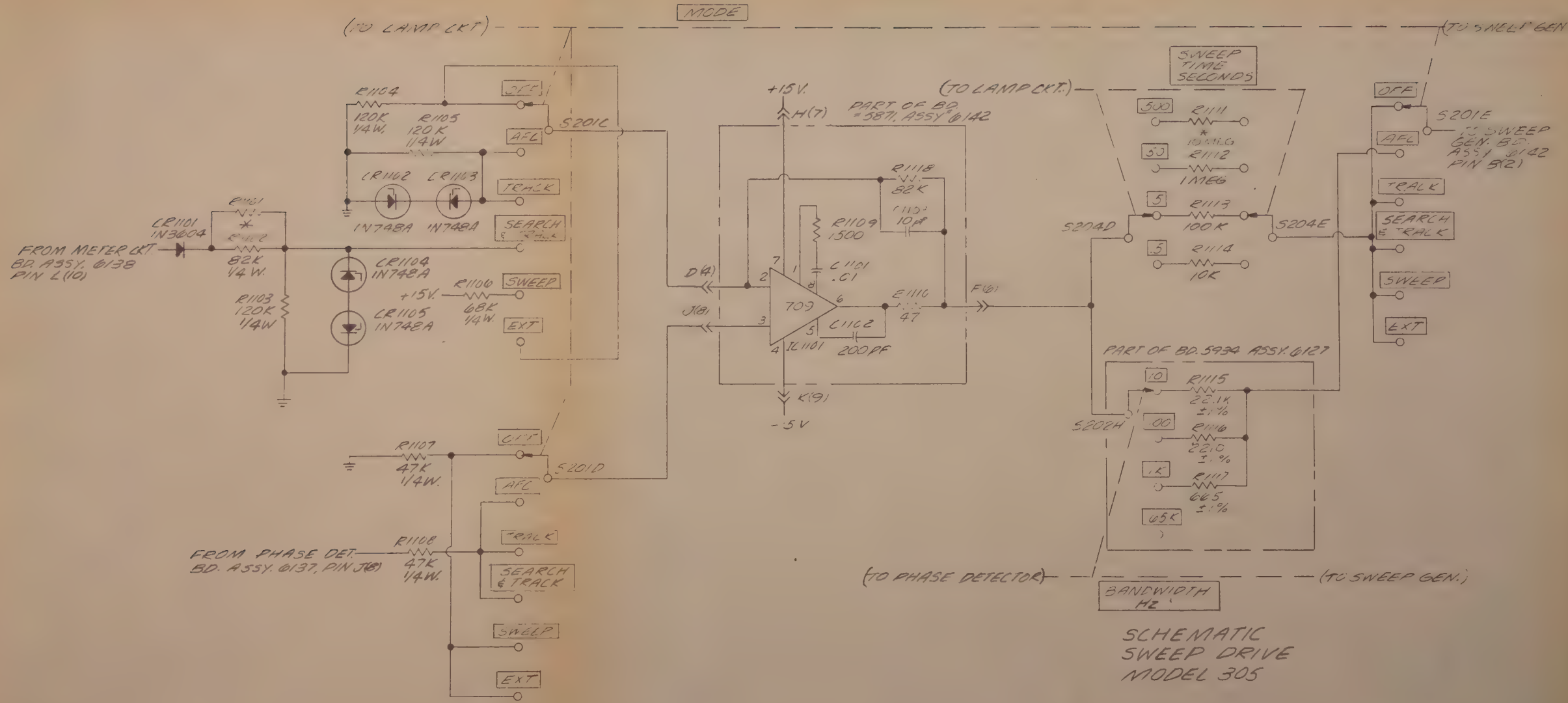
10 30 100 300 1000

R933 4620 ±1%

SCHEMATIC
PHASE DETECTOR
MODEL 305

C-6309-D

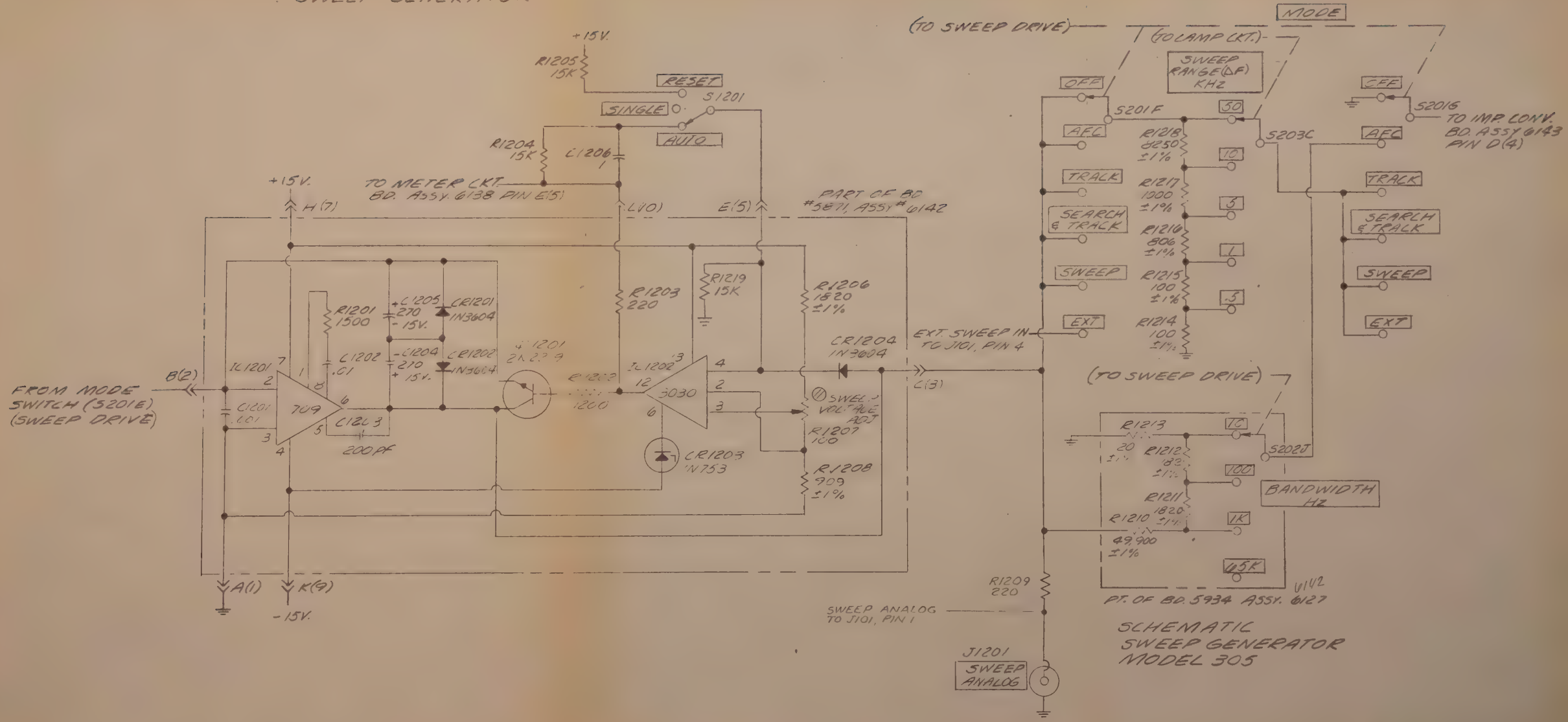

METER CIRCUIT
+15V.
N(2)
BD. #5932, ASSY. #6138
TO PHASE DET. BD. ASSY 6137 PIN D(4)
TO SWEEP DRIVE (CR1101)
L(10)
RMS MILLIVOLTS 28
B(2)
M-101
R1034 20K ±1%
R1035 1.47 MEG ±1%
R1036 1000
C(3)
METER ANALOG TO J101 PIN 2
METER ANALOG J1001
R1033 *
C1014 .01
R1032 1500
C1011 2250 pF
R1031 100
C1012 00 pF
R1030 316K ±1%
GAIN ADJ. R1029 50K
R1028 20K ±1%
R1026 18.7K ±1%
IC 1003
Q1003 2N3643
R1037 3900
C1013 1/100V.
E(5)
FROM SWEEP GEN. BD ASSY. 6142 PIN L(10)
R1038 27K
CR1003 IN3604
METER TC SECONDS
S1001
C1010 270 15V
K(9)
J(8)
R1022 100
R1020 6.81MEG ±1%
R1021 1MEG ±1%
R1023 3900
R1024 31600 ±1%
R1025 6800
R1027 *
C1004 .5 200V
R1018 6800
C1007 15 pF
C1008 560 pF
R1019 500
R1016 6800
R1017 1000 ±1%
C1006 .5 200V
R1015 180
R1014 0K
R1013 8200
R1012 220
C1005 56 pF
R1011 10K ±1%
C1003 .5 200V
R1005 560
R1004 5600
R1003 5600
R1006 330
C1002 .01 100V.
IC 1002
IC 1001
CR1002 IN3604
R1009 10K ±1%
R1010 220
C1001 56 pF
R1008 10K ±1%
CR1001 IN3604
R1007 5600
Q1002 2N3644
C1001 270 15V
R1002 1330 ±1%
Q1001 2N3643
R1001 470
X(21)
TROUBLING THRESHOLD ADJ.
M(11)
A(11)
Z(22)
N(19)
C1015 10 50V
-15V
D(4) F(6) H(7) P(3) R(4) S(15) T(16) U(17) V(18) X(20)
NO CONN.
TO BFO-RESTORED SWITCH (BFO-RESTORED CKT.)
R1040 47
CARRIER OUT TO J101 PIN 8.
SCHEMATIC METER CIRCUIT MODEL 305
T-6310-D



SCHEMATIC
SWEEP DRIVE
MODEL 305

T-6311-B

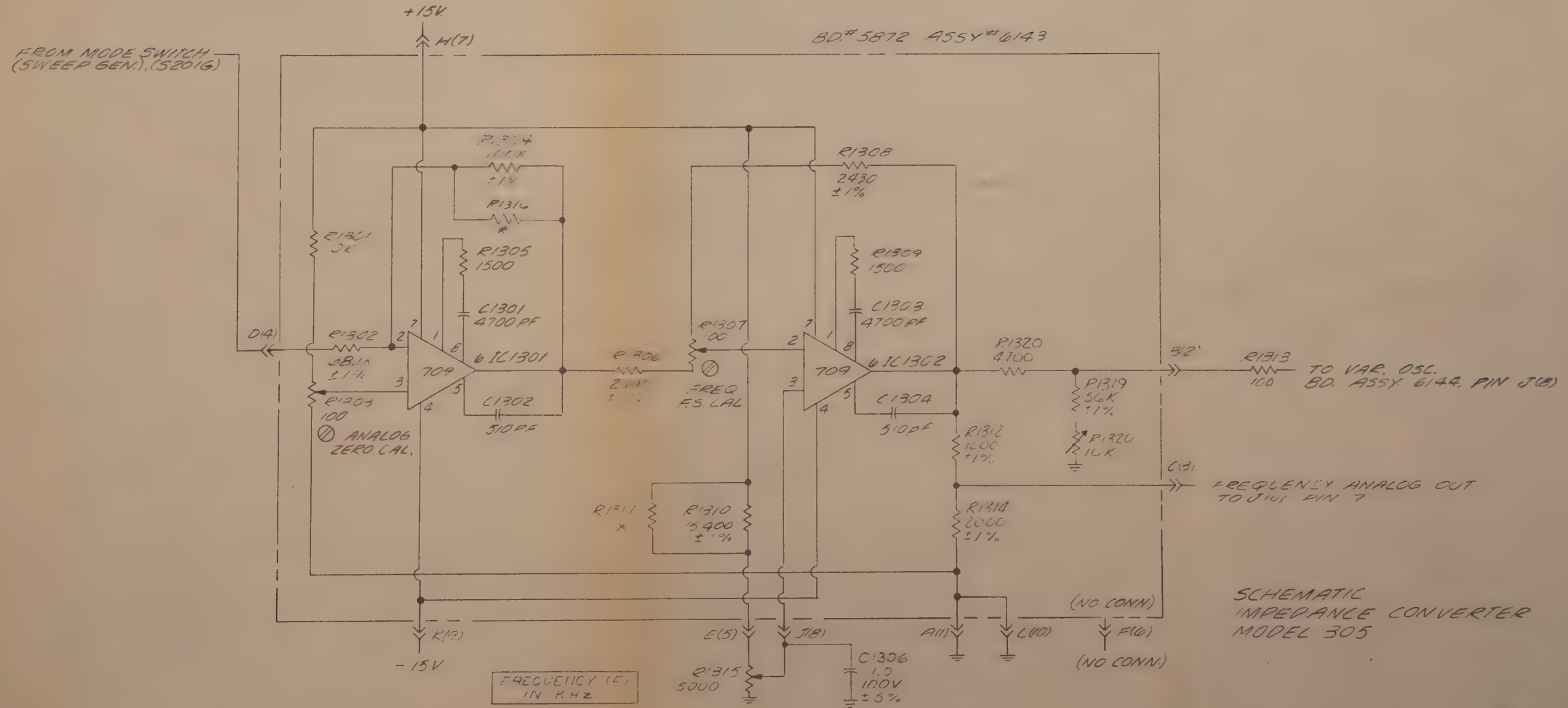
SWEEP GENERATOR



SCHEMATIC
SWEEP GENERATOR
MODEL 305

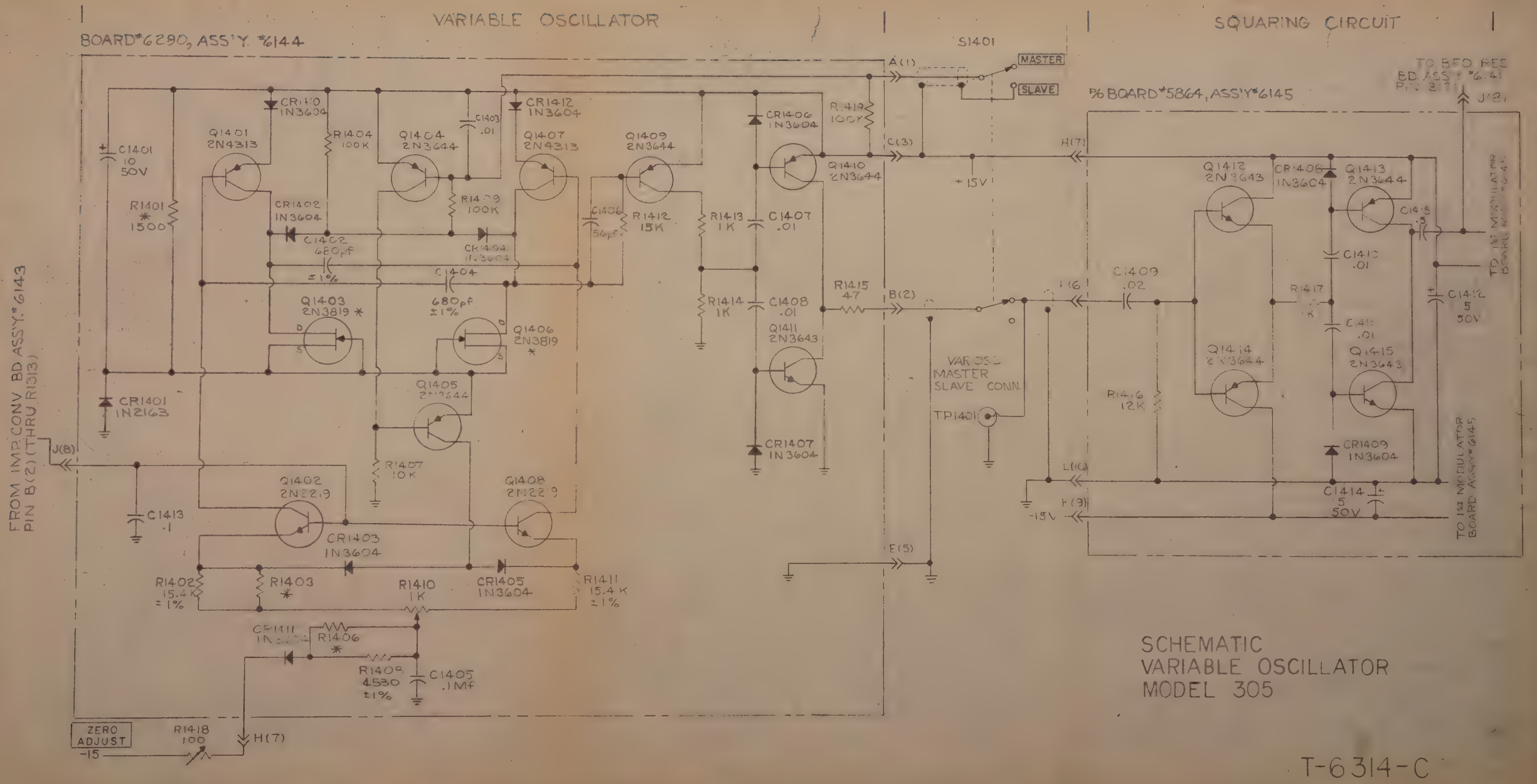
T-6312-C

IMPEDANCE CONVERTER



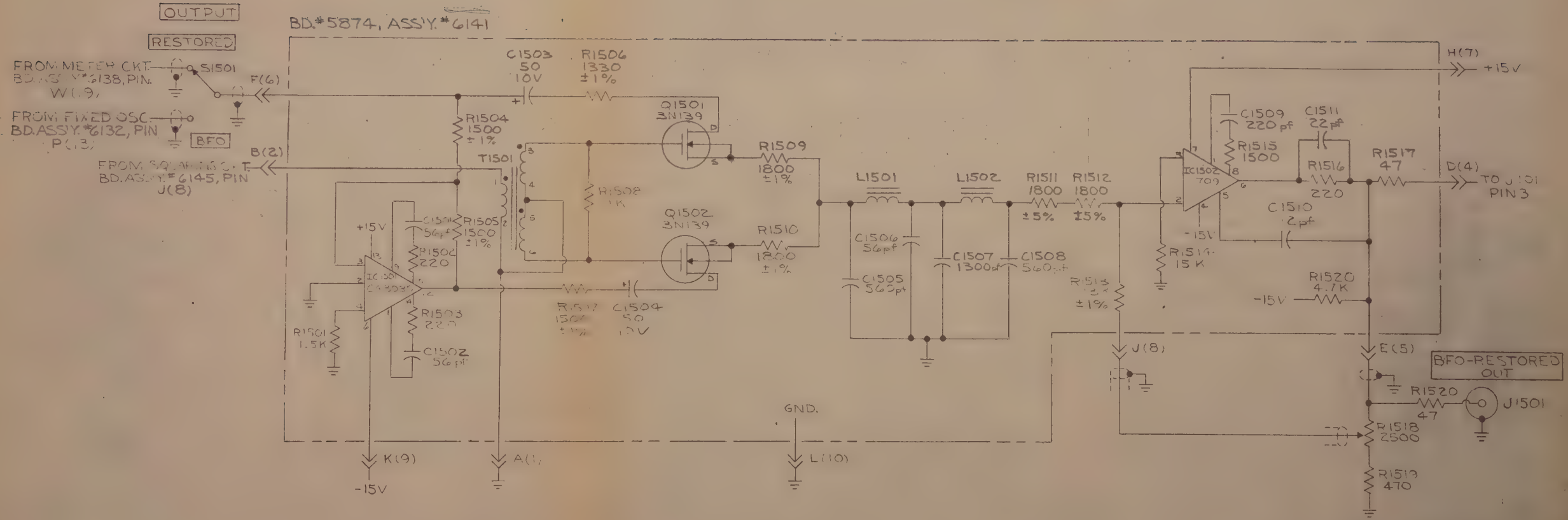
SCHEMATIC
IMPEDANCE CONVERTER
MODEL 305

T-6313 D



SCHEMATIC
VARIABLE OSCILLATOR
MODEL 305

T-6314-C



SCHEMATIC
BFO-RESTORED CKT.
MODEL 305

T-6315-C

Quan-Tech®

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INSTRUMENTS • AMPLIFIERS • NOISE INSTRUMENTATION

SHORT FORM CATALOG

370/5M/ASI